Eng. Lib.

COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

Vol. XVI MARCH, 1911 No. 3

Published by THE COMPRESSED AIR MAGAZINE CO., Easton, Pa.

NEW YORK, Bowling Green Building LONDON, 165 Queen Victoria Street

Classified Buyers' Guide, Page 12. Index to Advertisers, Page 8.

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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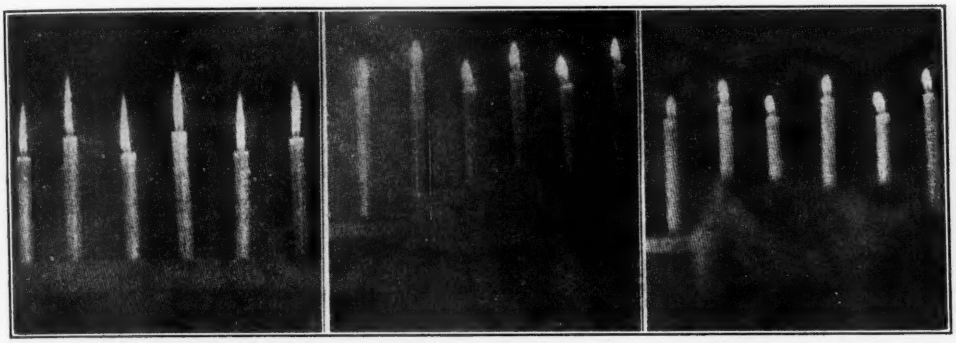


FIG. 1 FIG. 2. FIG. 3

CANDLE TESTS OF AIR FROM A HYDRAULIC COMPRESSOR*

BY F. W. MC NAIR AND G. A. KOENIG.

The recent discussion of the conditions in certain mines at Cobalt due to the use of air compressed hydraulically, may lend interest to an investigation made by the writers in March, 1907, at the Victoria mine, Ontonagon county, Mich. It will be remembered that a Taylor hydraulic compressor of the same type as that at Cobalt supplies compressed air at this mine.

Difficulty was experienced with the lights, and we were commissioned to examine the conditions produced, not only in relation to the lighting, but also with regard to persons who might work in such air.

The fact that water in intimate contact with air not only dissolves it, but takes up a greater percentage of its oxygen than of its nitrogen, has long been known. Over 50 years ago a French chemist proposed to get air for blast furnace use which would be richer in oxygen than normal air by the method of solution in water. Each successive solution will render the dissolved air richer in oxygen. Since the hydraulic air compressor delivers, not the air dissolved, but what is left, it follows that the air delivered must be poorer in oxygen than normal air.

Naturally the matter of first interest was the oxygen content of the "compressor air," next, whether its deficiency in oxygen was alone responsible for the action of the candles, which were said to burn in the mine from two to four times as long as under usual conditions, and lastly, the discovery of any deleterious effect on persons working in such air.

Determinations by means of a Hempel pipette, charged with thin sticks of phosphorus, showed an oxygen content of 17.7 volumes to the 100 volumes of compressor air, whereas in 100 volumes of normal air there are about 21.0 volumes of oxygen. A recently published

*Paper read before Section D of the American Association for Advancement of Science at the Minneapolis meeting.

analysis of the air from the Cobalt compressor gives 17.7 volumes of oxygen to 100 of air, which agrees with the determination at Victoria. This is what may be expected from a single solution. If, out of 100 volumes of normal air, the water extracts 2.15 volumes of nitrogen and 4.47 volumes of oxygen, the ratio of solution will be that given in the text books, and the resulting percentage of oxygen will be that found by us. It would at first seem doubtful that this shortage of 3.3 volumes of oxygen could cause the reported trouble with the lights.

At the time of our investigation the Victoria mine operated a single shaft which was in the neighborhood of 1,500 ft. deep, and in the plane of the lode. Some of the drifts were long, one breast being as much as 1,200 ft. from the shaft. As the mill was not yet completed, but little stoping had been done, and the total volume of the excavation was small compared to the average of the Lake copper mines. It should be noted, however, that the volume was large compared to that of any mine at Cobalt.

Air from the hydraulic compressor had been used throughout the mine for several months to operate drills, and to ventilate in the usual manner after blasting. While the upper part of the mine drew some air from a shallow shaft used for ventilation, it was altogether probable that the main portion below was entirely filled with compressor air.

To investigate the action of the lights six candles were chosen, three from each of the two kinds we found in use at the mine, one make being supposedly harder than the other. The six were carried throughout the tests without discovering any difference between them. As far as possible the observations were recorded photographically. To secure uniformity in observation, a T-shaped frame, or stand, 3 ft. wide by 6 ft. long, was constructed of 6-in. boards. It was laid flat, and on the cross-arm the candles were spaced 6 ins. between centers. The camera was placed at the end of the long arm btween guide marks. The candles were first lighted and observed on surface to get at the normal rate of burning, which was judged by the height and general appearance of the flame, together with the cup at the bottom of the wick. The flame condition in normal air is well shown by Fig. 1, taken in a room-temperature of 54 degrees at the Michigan College of Mines, after the observations at the mine.

On lighting these same candles underground, a marked difference in their burning was recognized, and, after observing their performance in different situations, it was easy to accept the statement of the length of time a candle would burn in the mine. The flame was in every case lower than normal and much more blunt. The "tail," partly of semi-luminous and partly of sooty carbon, so characteristic of the flame in normal air, was as a rule wholly absent. The cup was only meagerly supplied with melted max and showed a frozen appearance around the edge. We also remarked the ease with which a candle could be extinguished by a sudden sidewise movement.

Two examples of the photographs obtained in the mine are shown. Fig. 2 shows the appearance of the candles at the breast of the west drift on the 9th level. Before they were lighted air was blown from the hose for about 15 minutes to clear out fumes from a recent blast. Fig. 3 gives the most conclusive evidence of the effect of the compressor air obtained in the mine. For three-quarters of an hour a wide open 2-in. main delivered the air under 70 lbs. pressure at the breast of the 8th level west.. The candles were then placed, and the photograph taken. These flames were undoubtedly in the purest possible compressor air. Their shortness and bluntness is evident. It is worthy of note that while they were being photographed an acetylene flame burned brightly some 2 ft. away from them, burning at its maximum the entire time.

But one more step was necessary to finish the demonstration. In the laboratory one of the six candles was placed in a box with glass front, to which was supplied alternately normal air and an imitation compressor air, having the observed percentage of oxygen, but made in the laboratory. We could reproduce all of the phenomena of slow combustion, low flame and frozen appearance of the cup as observed in the mine. Fig. 4 shows the experiment in normal air, and Fig. 5 in the imitation compressor air. The flame in the latter case is less blunt than observed in the mine, owing to the stronger upward current, due to the more confined space, and possibly, owing partly to the higher temperature of the space.

Evidently the deficiency of oxygen in the compressor air is wholly responsible for the difficulty with the candles. The lower oxy-

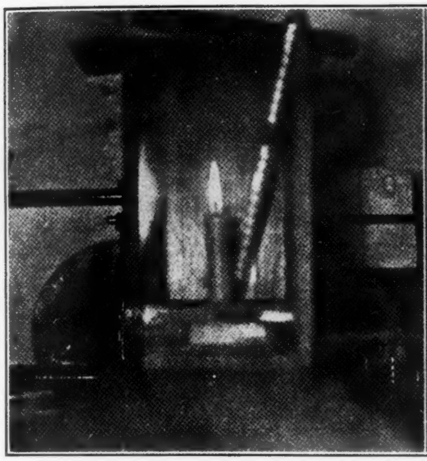


FIG. 4

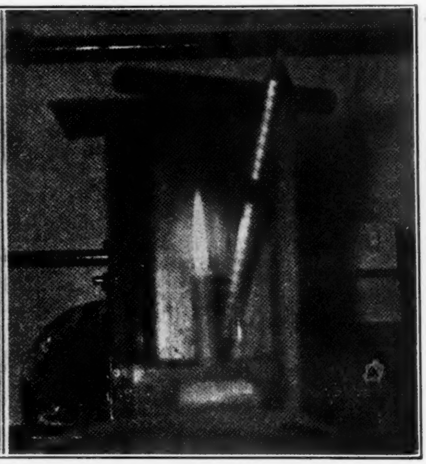


FIG. 5

gen content allows only a slower combustion, heat is supplied more slowly, the temperature remains lower, the wax melts at a slower rate, and is liquid over a smaller area. The acetylene flame, using an already gaseous fuel, is not so dependent on the rate at which heat is supplied, and so suffers no visible diminution.

Regarding the effect of this air on persons working in it, conclusive evidence is not so easily obtained. It is possible that the rate of breathing might be increased. The psychological obstacles in determining this at the mine were so great that it seemed futile to experiment. No one had complained of working in the air. There was a feeling, indeed, that it was better than the air previously supplied from the steam compressor. With senses alert and a keen desire to observe any such phenomenon, we were wholly unable to discover any effect on ourselves which could be ascribed to the composition of the air. Whether our exertions were mild or violent, our experiences were in no wise out of the ordinary.

It is interesting to note that this solution of air lowers what might otherwise be the efficiency of the hydraulic compressor. Tests made on the Victoria compressor by Professors Hood and Speer, of the Michigan College of Mines, shows, that if all the air drawn in at the intake were delivered compressed to 114-lb. gage, the compressor when absorbing 1961 hp. would show an efficiency of 82 per cent. If we assume, as above, that 6.6 volumes out of each 100 drawn in are diverted, the efficiency cannot be above 76.6 per cent.

Frizell, in his book, "Water Power," gives an elaborate and interesting deduction of the efficiency of such a compressor, based on theoretical considerations, and obtains a figure of under 70 per cent.

The engineer who first gets a commission to make a complete test of this compressor will, when his task is finished, be in a position to give some very interesting and important information.

THE ATMOSPHERE BENDS EARTH'S SHELL

The inventor of the seismograph, primarily for the study of earthquakes, has led to the discovery of the astonishing sensitiveness of the crust of the globe to forces that might have been thought too insignificant to cause distortion. Among these forces is the alteration in the pressure of the atmosphere during the passage of storms, causing a perceptible tilting of large areas of ground. A curious case of such tilting has been recorded in Japan. A storm passing over the sea east of Tokyo caused the bordering land to tilt downward, notwithstanding the fact that atmospheric pressure is lessened within a storm area. This is explained by the fact that the sea rises with release of atmospheric pressure, and the accumulation of water more than sufficed to counterbalance the decrease in weight of the air.

DANGER FROM WATER IN AIR FOR CONVERTERS

BY A. R. MC KENZIE.

If air at a higher temperature and saturated with water vapor is compressed, and while being conveyed for any distance has its temperature materially lowered, there is bound to be a condensation of moisture. In the compression of air for converter work, under such conditions, there is an element of danger presented. During my experience in copper converting at least two glaring instances of this phenomenon have come to my notice.

An exaggerated case occurred about four years ago at a smeltery at a high altitude. The power house at this plant was about 1000 ft. away on the same level as the blast furnace feed floor. From the power house the converter main passed through a tunnel in the brow of the terrace to within 70 ft. of the furnace building, whence it passed diagonally across to the outside of the converter crane track, when it entered the converter building, and from there it was curved downward to the level of the mouth of the converters, when they were in the upright position in the stalls. Before reaching the converters the pipe was enlarged to a diameter of about five feet, which served the purpose of a receiver or reservoir. The connection to each converter was made from the side of this reservoir, which ran along behind the converter smoke boxes.

One rainy day, about two o'clock in the afternoon, four months after the plant had been in operation, I noticed water coming out of some tuyeres which were leaking air around the ball valves. I immediately had all the converters shut down in order to ascertain the source of this water. On account of the rainy weather, my first supposition was that the water had got to the intake of the compressor and was being pumped to the converters with the air, but I soon discovered that such was not the case. I next made an examination of the five-foot reservoir by tapping it with a hammer. From the sound I judged it was full of water up to the outlets, where the side connections were made to the converters. A scaffold was hurriedly built and an air-power drill set in place. In a few minutes a stream of water was running from an inch hole in the bottom of the reservoir, the total amount of water drained from this pipe amounting to about 100 bbl. Afterward I had this hole fitted with a 1-in. drain pipe, with a valve which was kept slightly open to prevent a recurrence of what had taken place.

In the design of converter plants, care should be taken not to tap the converter air main from the bottom, for in case one of the converter stalls should be shut down for any length of time, the air pipe leading from the air main to the stall might fill with water, and in again putting this stall in operation, there would be danger of an explosion unless the collected water were removed. The difference in temperature between a hot engine room, where a number of machines are running, and the outside atmosphere, is so great, especially in cold weather, that condensation of moisture in the pipes goes on rapidly, and may become a source of danger in any case unless special means of drainage are provided. It may be thought that, in plants in continuous operation, enough water would never come through the main to cause an explosion, even without any special means of drainage, but the following may be assumed to show that such danger exists.

Suppose that one or two converters have been running for some time, and that some condensation of water has taken place in the air main. Then, should the number of converters be increased to four or five, as frequently happens in meeting changing requirements of production, etc., the volume of air passing per minute will be perhaps doubled, tending to form waves and to sweep it into the connecting pipes, whence it will pass into the converters and cause an explosion. During intermittent operation there is no question of the danger. Some years ago, at another plant at which I was employed, a stall which had long been idle was again put into service. The converter was connected in place and charged, without examining the piping, which had slowly collected condensation water back of the valve. On turning into the stack and putting on the air, this water was carried into the tuyeres and blew the converter bottom to pieces.—*Eng. and Min. Journal.*

Only two "horse-powers" are recognized in engineering: the unit of 33,000 foot-pounds per minute and the unit of 4,500 kilogramme-meters per minute, which is 32,549 foot-pounds, and is known as the metric or French horse-power.

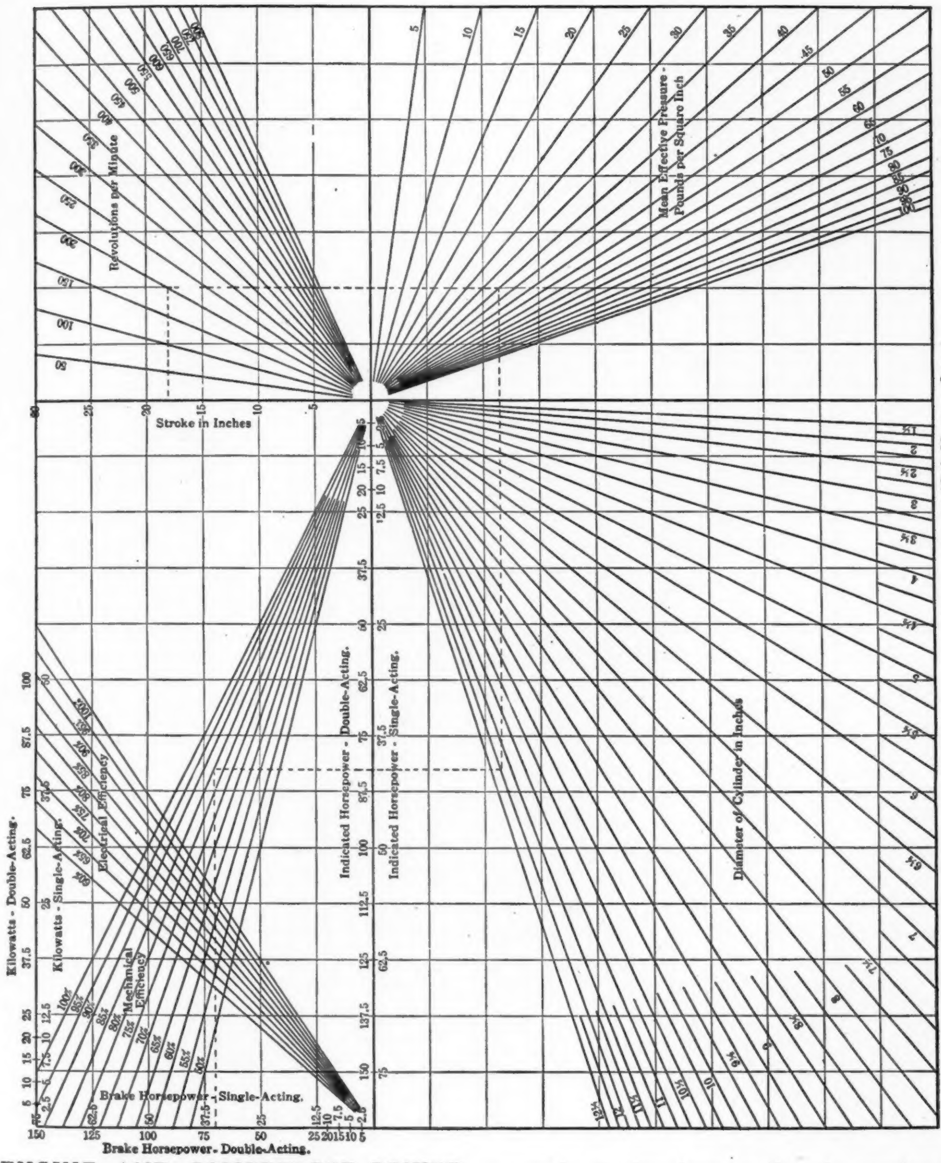


FIG. 1. HORSEPOWERS OF ENGINES UP TO 12½x30-INCH SIZES

ENGINE AND COMPRESSOR POWER CHARTS

BY T. M. CHANCE.

One of the most frequent calculations made by mechanical engineers is the horsepower of engines and compressors. When rough estimates of the power delivered by an engine of certain dimensions are hurriedly made, errors often occur from the improper use of the formulas or quantities under consideration. For example, it often happens that the number of revolutions is used as the value of the quantity N in the formula

$$\frac{PLAN}{33{,}000}$$

instead of the number of strokes per minute, and in a double-acting engine this gives a result only one-half as large as that which should be obtained. Similar errors, as well as arithmetical inaccuracies not due to ignorance, are

of common occurrence and may lead to large discrepancies in the subsequent result. It occurred to the writer that if a curve, or a series of curves, could be devised which would show at a glance the indicated brake and electrical output of an engine of any size, stroke, mean effective pressure and revolutions per minute, it would be exceedingly convenient and useful to engineers.

In the accompanying diagrams the horsepower rating is based upon the formula

$$\frac{PLAN}{33{,}000} = I.\ h.\ p.$$

Where,

P=Mean effective pressure in pounds per square inch;

L=Stroke in feet;

A=Area of the piston in square inches;

N=Number of strokes per minute (twice the number of revolutions).

And,

I. h. p.$\times$m=Brake horsepower;

B. h. p.$\times$e=Kilowott ratings;

Where,

m=Mechanial efficiency of the engine,

e=Total efficiency of the generator.

In the diagram the stroke of the engine is laid off in inches instead of feet, and the diameter is similarly measured, the inch being the most convenient unit for this purpose. It should be noted that the horsepower varies directly with the area of the cylinder, that is, as the square of the diameter; hence the diameters must be spaced proportionately to their squares, since they graphically represent the areas of the cylinders.

The diagram is here given on two scales: Fig. 1 to be used for engines up 12½ inches cylinder diameter and 30 inch stroke; Fig. 2 including engines up to 25 inches cylinder diameter and 60 inch stroke.

Referring to Fig. 1. suppose it is required to compute the horsepower of a 12x18 inch engine working under 40 pounds mean effective pressure and running at 200 revolutions per minute, the dotted line indicates the steps taken in the solution of the problem. Reading up the scale of "Stroke in Inches" to 18 inches, follow horizontally across to the intersection of this line with the diagonal line marked 200 on the scale of "Revolutions per Minute;" from this intersection drop vertically downward until the diagonal line marked 40 on the scale of "Mean Effective Pressures" is crossed; follow horizontally across from this point to the line marked 12 inches on the "Diameter in Inches" scale and, running vertically upward from this intersection to the scale of "Indicated Horsepower, Double Acting," the result is found to be 82.5 indicated horsepower. If it is desired to find the horsepower of the engine running single acting, it will be found to read 41.25 indicated horsepower on the lower scale of "Indicated Horsepower, Single Acting."

If the brake horsepower and kilowatt capacity of the engine is desired, assuming 85 per cent. mechanical efficiency and 95 per cent, generator efficiency, read vertically upward along the 82.5 indicated horsepower line to its intersection with the diagonal line marked 85 per cent. on the scale of "Mechanical Efficiency;" the horizontal line passing through this point shows the brake horsepower to be 70 on the scale marked "Brake Horsepower, Double Acting." To determine the electrical output, follow vertically upward from the intersection of this horizontal line with the line passing through 95 per cent. on the scale of "Electrical Efficiency" and read 50 kilowatts on the scale marked "Kilowatts, Double Acting." The same use may be made of the single-acting scales for the brake horsepower and kilowatts output as was done in the case of the indicated horsepower.

Where refinement in the calculations is desired, the decrease in power due to the reduction in effective area of the piston on account of the piston rod and tail rod, if the latter is used, must be computed. This is easily done with these diagrams by considering the piston rod and tail rod as two single-acting engines, having a cylinder diameter equal to that of the rods and working in opposition to the engine. When the piston rod and tail rod are of the same diameter they may be considered as one engine, running double acting. Therefore, if the decrease in power caused by the piston rod of a 100-brake horsepower engine amounted to 2 brake horsepower, the actual brake horsepower delivered by the engine would be 98.

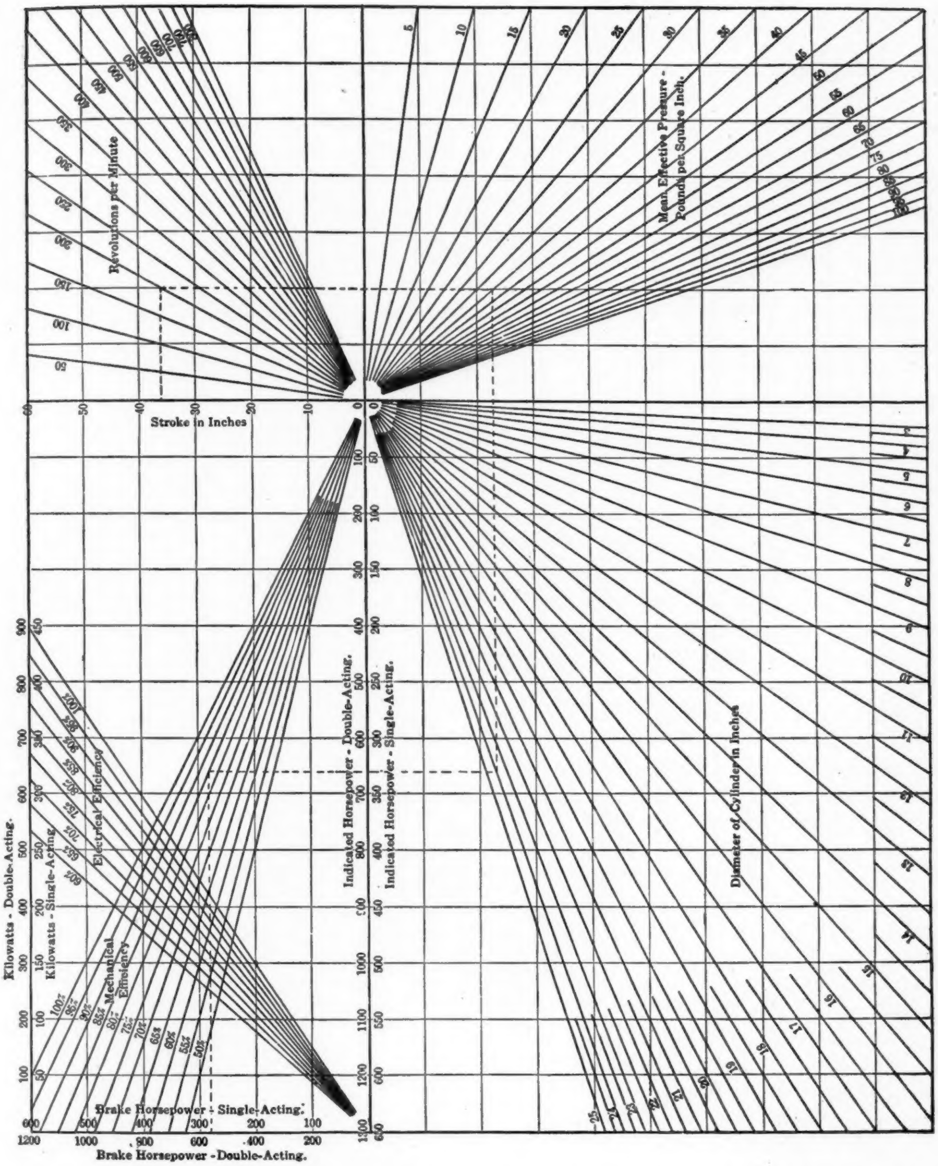


FIG. 2. HORSEPOWERS OF ENGINES UP TO 25X60-INCH SIZES

The diagrams are also useful in calculating c(ompressor dimensions. For example a compressor is to be installed to develop 660 indicated horsepower; the stroke of the compressor is 36 inches, the mean effective pressure 40 pounds, and the diameter of the cylinder 24 inches; find the number of revolutions. The dotted line in Fig. 2 indicates the steps take in the solution of this problem. Starting with 660 on the scale of "Indicated Horsepower, Double Acting," drop vertically downward to the diagonal line marked 24 on the scale of "Cylinder Diameter in Inches." From this intersection follow horizontally across to the diagonal line marked 40 on the scale of "Mean Effective Pressures" and from this point run vertically upward to the intersection with the horizontal line passing through 36 inches on the scale of "Stroke in Inches." A diagonal

line passing through this intersection and the common center of all the diagonal lines gives the number of revolutions, on the scale of "Revolutions per Minute," which in this case is 200.

The diagram may also be used to directly calculate the dimensions and power of gas or oil engines, if of the two-stroke type, as the horsepower of engines of this type is computed by the same formula as that used in steam-engine calculations; hence,

$$I.\ h.\ p. = \frac{PLAN}{33{,}000}, \text{ for double-acting engines}$$

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 2} \text{ for single-acting engines}$$

In the case of four-stroke engines the result obtained by the use of the diagram must be divided by two, as the four-stroke engine receives but half as many impulses as the two-stroke machine, during the same number of revolutions; that is,

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 2} \text{ for double-acting engines}$$

$$I.\ h.\ p. = \frac{PLAN}{33{,}000 \times 4} \text{ for single-acting engines}$$

When determining the dimensions of a four-stroke engine it should be remembered that the principle dimensions of a four-stroke engine and those of a two-stroke engine of twice the power are identical; hence, read twice the power of the machine under consideration on the horsepower or kilowatt scales and proceed as if the dimensions of a two-stroke engine of that power were being computed.—*Power and the Engineer.*

The deepest gold mine in the world not long since was that of the New Chum Railway company at Bendigo, Australia, down 4,120 ft. but this has now taken second place, the shaft on the Victoria Consolidated, also at Bendigo, having reached 4,600 and going to 5,000 ft. This is deeper now than that of the deepest gold mine in America, the Kennedy, at Jackson, California, by more than 1,000 feet.

SUBMARINE DIVERS IN MINES

The use of divers is a comparative novelty in the West, therefore the following account from letters of Herbert A. Wilcox, superintendent of the smuggler Mining Co., at Aspen, Colo., and W. J. Stevenson, manager of the Helena shaft, at Leadville, Colo., dealing with the work of two submarine divers in repairing submerged pumps at their respective operations, is of interest.

In describing the work at Aspen, Mr. Wilcox says that the collar of the Free Silver shaft, which is 1,196 feet deep, is 8,036 feet above sea level. The first connection underground is 848 feet below the collar and is with the ninth level of the Smuggler Mine. Below the nnith level, at intervals of 116 feet each, are the tenth, eleventh, and twelfth levels, the latter being at the bottom of the shaft. The mine below the ninth level has been under water for 12 years except for a few months in 1902 when it was unwatered to the eleventh level for exploration work.

At the lowest level, the shaft bottom, is a Jeanesville 32"×14"×48" duplex plunger pump which, when the mine was allowed to fill 12 years ago, was left with connections arranged that it might be started under water with compressed air. This pump has not been in operation since that date except during the brief period of exploratory work in 1902.

When the present unwatering was contemplated it was found impossible to operate this pump, and its action led the management to believe that its packing had failed. As the inflow of water was great and the shaft small, it was found impracticable to unwater with sinking pumps. Although the flow of water at the eleventh level was at the rate of 1,500 gallons per minute it was lowered to this point by means of Pohle air lifts and Starrett air pumps delivery to the regular station pumps at the ninth level. As the mine equipment was insufficient to lower the water beyond the eleventh level, Messrs. Fred. Johnson, diver, and George Peterson, tender, were called from New York, arriving in Aspen on October 17. On October 23, when the water was 103 feet deep, its surface being 6,943 feet above tide, the diver, after several attempts, reported his inability to work in this depth at the altitude, although at sea level he could work in 120 to 130 feet of water.

A station pump was then installed at the

eleventh level and, with this and the Pohle and Starrett pumps in the shaft, the water was lowered to within 71 feet of the bottom by November 16, when the diver returned to work. During the next 10 days, while the diver was making the repairs, the water was held at a depth of from 71 to 65 feet. After the long submergence the packing in the water plungers was found to be in fairly good condition, but that in the steam end was entirely gone, and the piston rods were found to be very rough. By November 26 additional packing had been placed in the water end and all the glands tightened, the steam end had been repacked throughout, the rods smoothed, all nuts carefully gone over and tightened, and jam nuts added where it was necessary.

The pump was started the next day on a mixture of steam and compressed air and has been running ever since with a piston speed of 120 to 136 feet per minute, with the exception of one shut-down of 4 days and several others of a few hours each, none of which, however, was due to any failure of the pump. The diver examined the pump on December 2, and again on the 14th, each time finding it advisable to add more packing to the steam end and to tighten the glands. At the date of Mr. Wilcox's letter, December 18, the pump was working nicely, and as there was but 10 feet of water in the station, he expected to recover the main pump in a few days.

Mr. Johnson had only been in Aspen 6 days when the preliminary trials were made. In diving in 103 feet of water he complained of shortness of breath, panting, and inability to exert himself without immediate and complete exhaustion, and described his sensations as being the same as when working at sea-level at greater depths. Mr. Johnson estimated the effect of the altitude to be equivalent to that of about 27 feet of water at sea level. While the repairs were being made Mr. Johnson had no occasion to work under a greater pressure than 71 feet of water, and while not certain, does not believe he could work in mountain regions at as great depth as at sea level, even after becoming accustomed to the altitude.

Immediately after leaving Aspen, Messrs. Johnson and Peterson went to the Helena shaft, in Iowa Gulch, Leadville, the collar of which has an elevation of very nearly 11,000 feet, considerably above that of the Free Silver shaft at the former town. In describing the work at the Helena, Mr. W. J. Stevenson, the manager, says that when the mine was closed down some months ago the valves of the station pump at the 500-foot level were left closed and consequently had to be opened before the pump could be started and the lower portion of the shaft unwatered.

The Helena shaft consists of two 4′ × 8′ compartments, in one of which are the pipe lines connected with the pumps, and which are supported by the stulls. Mr. Johnson at first attempted to lower himself in the pipe compartment, but was stopped by a pair of misplaced stulls just above the pump, and was unable to get between them and the side of the shaft. A second attempt was made to get down through the hoisting compartment, in which a Starrett air pump was working. This pump works entirely under water, and at the Helena shaft had been so placed that the exhaust took place about 2 feet above the top of the pump. This attempt also resulted in failure, as each time the diver got within about 4 feet of the exhaust he was blown back by the force of the air.

Unfortunately, a Cameron sinking pump had been wedged across the hoisting compartment, just below the station, so that ordinary sinking pumps could not be lowered. After several attempts, the pipes to give the necessary submergence for an ordinary air lift, were pushed past the obstructions, and when the water had been lowered to a depth of 50 feet Mr. Johnson was able to descend and open the valves in the station pump.

It will be noted that the surface of the water under which the diver worked was at Leadville 10,450 feet, and at Aspen 6,943 feet. This difference of 3,507 feet must have had some effect upon the ability of the diver to work, but Mr. Stevenson is of the opinion that the men labored under no greater disadvantage than would any one unaccustomed to the altitude.

While the work required of the diver at Aspen was much greater than at Leadville, in each instance most important service was rendered, and portions of the mine per force abandoned or only recoverable after long delay and great expense for new machinery, were cheaply made available for development. As Mr. Stevenson justly says, the remarkable feature is that the divers work entirely in the dark, guided only by their sense of touch and a thorough knowledge of their work.—*Mines and Minerals.*

SOAPSUDS TO LAY THE DUST IN COAL MINES

Dr. Thornton, Professor of Electrical Engineering at Armstrong, College, Newcastle, England, has made some interesting experiments in connection with the laying of coal dust in mines. Water has no binding effect upon the coal dust; when the moisture has dried up, and when the dust has become dry again, in the event of spraying being neglected, it returns to its former powdery state. In some mines calcium chloride has been tried; but while this has certain advantages in the way of binding properties, it converts the wetted substance into an unpleasant, sticky mixture. Professor Thornton has gone to work to find something which might offer more satisfactory results, and his experiments have led him to the belief that an efficacious spraying mixture can be made with soap and water. Dr. Thornton demonstrated the excellent binding properties of the mixture of soap and water, and, further, he showed by the experiments that the whole question of the wetting of the dust was one of surface tension of the liquid used, and that the water alone did not readily and entirely wet the coal dust, unless used in very large quantites. The mixture of soap and water, however, completely wetted the dust, and turned it into a liquified form of mud, of which the chief component was coal dust. Therefore, whilst with water alone, as shown by the French experiments, ten times the weight in proportion to the amount of coal dust is required to wet the dust, with the use of a soap solution a much less quantity of spraying liquid would be required, and the result would be much more satisfactory than with the water.

Important as this is, it is not the most important point of Dr. Thornton's suggestion. His demonstrations showed that coal dust which had been sprayed with water and then re-dried could be easily blown into the air, but coal dust which had been sprayed with the soap solution dried in a form more closely resembling a distemper than anything else, and this could not be blown into the air. It could be loosened from the surface upon which it had been placed for the purposes of the experiment, only by rubbing with the fingers. In carrying out the experiments the quantities of coal dust used were far in excess of the quantities found on a proportionate surface in the pit, and the consequence was that owing to the extra thickness of the dust it could be more readily loosened with the fingers than would be the case with a thinner layer, such as would be met with in practice, as Dr. Thornton has previously found out by experiment.

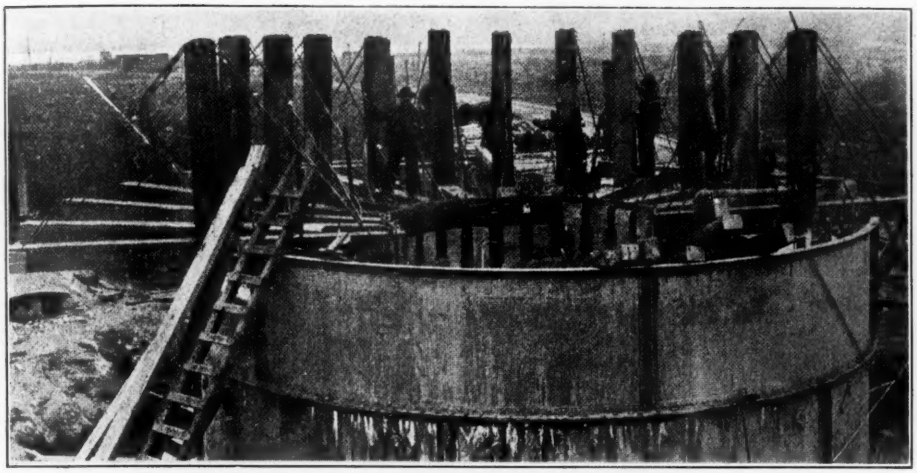
The results of these experiments go to show that if a percentage of soap was mixed with the spraying water the coal dust would receive a thorough wetting, and in the case of an explosion, even though it had become dry, it would still adhere to the surfaces upon which it had become deposited, and would not become food for the fire. There would consequently be less likelihood of the fire spreading through the workings than if coal dust were present in the air. Professor Thornton pointed out that the quantity of soap which was necessary, so far as the experiments indicated, was not great. Any kind of soap could be used for the process, and it was very probable that some of the by-products and residues obtained in the manufacture of soap would serve the purpose equally well. The best effects in the experiments were obtained with a fine spray.

SINKING AND STEERING A DEEP CONCRETE SHAFT

For the following account of the sinking of a deep shaft at Hibbing, Minn., with the accompanying illustration we are indebted to *Engineering-Contracting*. Many interesting devices were employed upon this work, among which was the method used for plumbing the shaft as it was sunk, by means of eccentric or overhung loading. The half tone shows a system of trussed supports built out for loading the shaft on one side. The method has the effect of a cantilever and reduces the load necessary to accomplish the desired effect.

The work at Hibbing is being done by the Foundation Co. of Chicago. It is of special note because the shaft has been sunk 164 ft. below water level, or in all, 185 ft. below the surface of the ground.

The friction of the outside surface of the concrete shaft with the ground through which it is sunk varies from 250 lbs. to 1,200 lbs. per sq. ft. of surface, depending upon the character of the soil. The friction is greatest in sand and quicksand and least in clay.



CANTILEVER FOR TRIMMING CAISSON.

For reducing the friction, water jets are run down between the shaft and the soil at short distances apart around the circumference of the shaft.

The shaft is 29 ft. in diameter with a rectangular cageway 10 ft. - 10 in. x 14 ft.- 10 in.

The shaft is made circular because of the saving in surface friction over that which would obtain with a rectangular shaft of the same size.

The outside forms were of steel plate placed in 5 ft. sections. Three sections were used for ordinary sinking, the bottom section being removed and placed at the top as fast as the concreted sections were sunk.

The inside forms were of wood, made in 5 ft. sections using a set of 6x6 in. dressed timbers braced across the corners with 3x6 in. pieces. The 6x6 in. timbers were tied at the corners with 4x½ in. iron straps. The timber sets were placed at 30 in. centers and 2 in. sheeting was used. The rectangular opening was made 4 in. wider and longer than was required by the plans in order to care for any small inaccuracy due to the shaft being out of plumb when bed rock was reached.

In sinking the shaft the excavation was at first carried on through the cageway by using the clam shell bucket attached to the derrick. When the excavation had proceeded to a depth at which it was impracticable to dig with the clam shell a Moran lock was installed and the work was carried on under the pneumatic process. Air pressure was not put on until the shaft had reached a depth of about 166 ft. An air pressure of 47 lbs. per sq. in was used, and 40 min. shifts were worked.

[The above maximum air pressure was reached or slightly exceeded, in sinking the foundations for the new Municipal Building in New York, as described in our issue of July, 1910. In that case there was an actual head of water at the caisson corresponding to the air pressure within, or actually 112 feet. In the above case the water could not have had the effective head at the work of 164 feet as mentioned above, as that would have required an air pressure of about 72 pounds. Ed. C. A. M.]

AN ADDED TERROR OF WAR

An aviator near San Francisco took up with him as a passenger in his aeroplane, an ordnance officer of the United States Army, and the latter dropped from a height a specially prepared hand-bomb which exploded with terrific violence upon striking the earth. An examination of the vicinity where the bomb struck proved that a shell of this description, when exploded, scatters in all directions the materials of which the shell is constructed, as well as those with which it is filled, and that it would be very destructive of life within a radius of many feet. It is fair to assume that this dropping of explosive bombs from the sky must have a powerful "moral" effect, as they call it, upon armies in the field, since it is a terror which cannot be ran away from and against which there can be no real protection.

VACUUM STRIPPERS FOR CARDING ENGINES

When the cotton spinner receives the raw cotton, it contains a number of impurities, such as broken leaf, seeds, sand, etc. The heavier impurities are got rid of in the scutching processes, which are carried out in machinery specially designed to prevent the dust getting into the atmosphere. When the raw cotton has gone through this process, it passes to the carding engine where, by means of wired cards, the cotton fibres are arranged in parallel order and the cleansing process previously referred to is completed. A large proportion of the foreign material lodges in the card clothing of the cylinders and flats, and which have to be periodically cleaned. The cleansing process is universally known as "stripping," and is accomplished by means of a wire brush which is caused to revolve, and is brought in contact with the card clothing from which it drags out the matted mixtures of cotton fibre, fluff, and dirt, The process, although effective, does not comply with the requirements of the hygienic conditions which are now considered essential in cotton mills on account of the amount of dust which is given off, irrespective of the wear and tear of the bearings of the machinery caused by the introduction of grit.

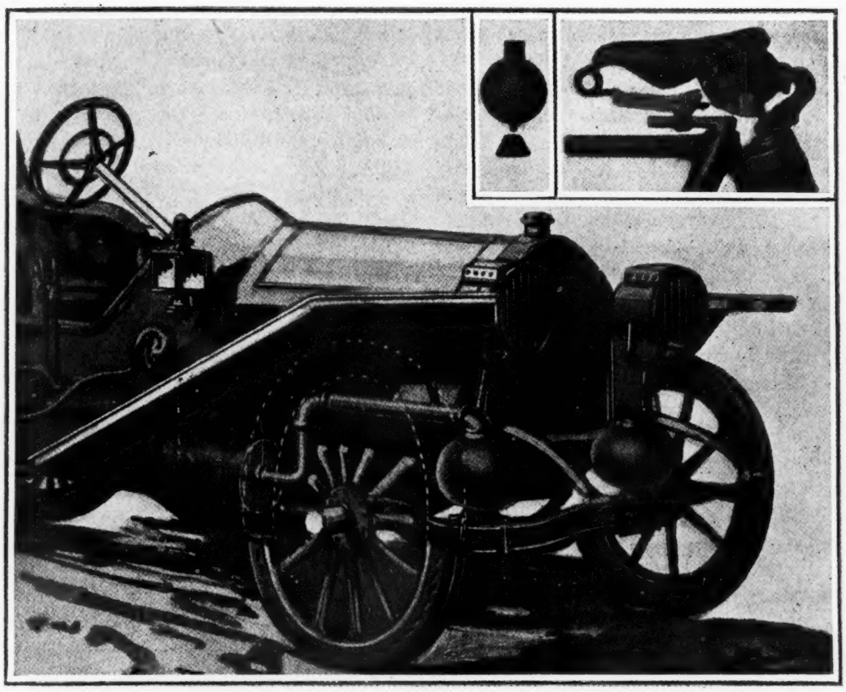
Inventors are busy attempting to devise some satisfactory appliance to obviate the defects referred to, and Cook and Co., Exchange street, Manchester, are introducing a system which does away with the brush altogether. It depends, for its successful action, upon a high vacuum, the stripping operation being performed by means of nozzles travelling across the faces of the cylinders and doffers. The end of the nozzle comes within about 1-16 in. of the wire clothing, and the inrush of air, brought about by a central air pump, draws into the nozzles all the material which is held by the wires. The strips, dirt, etc., are carried away through iron piping 1½ in. internal diameter to a suitable receptacle where they are collected, no dust being given off in the operation. One advantage claimed for this system is that the cards can be stripped while working, which results in increased production. Another advantage possessed by this apparatus is that it enables the mill owner to do away with the locking motions for the carding engine doors which are required by the Government inspectors.

The nozzle is a permanent fixture upon each carding machine, and is mounted on suitable traversing mechanism, the point of the nozzle running along a narraw slot cut in the back plate. The doffer nozzle is fixed in a similar cross-traversing device working above the doffer comb, but in the latter arrangement the whole mechanism is portable, so that it can be carried about from machine to machine. For the doffer nozzle mechanism the usual grinding brackets are used, while special brackets are necessary to receive the cylinder nozzle and its mechanism. In both cases the mechanism is actuated by a rope pulley driven from a convenient pulley on the card. The central receiver for the strips is a large cylindrical receptacle, 10 ft. high by 3 ft. 6 in. diameter, made perfectly air-tight, and provided with a suitable door for clearing out the deposited material. It contains a cloth filter bag to prevent dust being drawn into the pump cylinders. From the receiving chamber a main pipe, 1½ in. in diameter, is run round the card-room, and on this at suitable intervals branches are provided, to which one end of a flexible tube is attached the other end during stripping being connected to the cylinder or doffer nozzle on the card.—*The Engineer*, London.

REHEATING IN MINES

In a paper read before the Transvaal Institute of Mechanical Engineers, Oct., 1910, R. G. Mackie says: "the reheating of compressed air underground and close to its work will receive more attention in the future than has been given to it in the past. Having to burn coal, coke and other combustibles underground, and the undesirability of introducing anything which is going to increase the temperature of the mine, has been the greatest objection to the reheating of compressed air in the mines. When the underground application of cheap electricity becomes general, the question of reheating air by electrical appliances is bound to be seriously considered. The reheating of the air should be done as near to its work as possible to reduce losses caused by radiation in the pipes between the heater and the drill. Less radiation means less interference with the mine temperature and increased expansive energy of the air."

The reheating suggestion is correct, but it is quite generally understood that even cheap electricity is not cheap when employed for heating purposes.



PNEUMATIC SPRINGS EOR AUTOS.

A PNEUMATIC CUSHION SUBSTITUTE FOR AN AUTOMOBILE SPRING

There has recently been invented by a California mining engineer a novel substitute for springs and shock absorbers on automobiles. This is a pneumatic cushion which appears to have advantages, because it permits the use of solid tires.

The inventor of this new device has found it impossible not only to construct a pneumatic shock absorber, but so to arrange this that it takes the place of the spring itself, while at the same time preventing any rebound.

In its present state this pneumatic cushion consists simply of a round rubber bulb six or eight inches in diameter, having an open neck at its upper end, and a small projection at its lower. This projection fits into a hole in a conical wood block that is secured to the axle of the automobile, while the neck of the bulb is set into a pipe fitting attached to the body of the machine. This pipe, of about 1½ inches diameter, connects to a tank having a capacity of 2,000 cubic inches. Four such bulbs replace the springs of an automobile. In fitting them to a car, the leaves of the springs are removed with the exception of the outer heavy leaf, which is used for steadying purposes. All four tubes are connected by separate pipes to the tank.

The action of the bulb is as follows: When a wheel of the car passes over an obstruction, the bottom of the bulb resting upon the cone-shaped block is pushed inward, and the surface of contact of the bulb with the block is increased. The heavier the blow, the more the block sinks in; consequently, there is a continuously increasing supporting area within the bulb upon which the air acts, the air being under a compression of about 20 pounds to the square inch in the bulb, the pipe line, and the tank. As a result of the increasing flattened area in the bottom of the bulb under a heavy shock, there is a cushioning effect that increases with the blow, and when the initial shock has been absorbed, there is no rebound, since the air in the bulb, piping, and tank has not been appreciably compressed. The cushion acts upon the same principle as the pneumatic tire, since the supporting area is increased when the bulb is flattened, in much the same way as it is with the tire; but in this case there

is no increase in air pressure, owing to heating of the air, and consequently no liability of bursting.

The air cushion makes it possible to use solid tires upon all commercial vehicles no matter what the size, as well as upon pleasure cars where it is desired to dispense with the costly pneumatic. The life of a good solid tire is easily double that of a pneumatic. For heavy work eight 12-inch bulbs, using an air pressure of 80 pounds and deformed to 8 inches vertical diameter, will sustain a weight of 15 tons and have a maximum carrying capacity of 24 tons, while 16-inch cushions will carry minimum and maximum loads of 30 and 48 tons, respectively. The rubber bulbs that have been tested in actual use are 8 inches in diameter with a 1 3-4 inch orifice at the neck. They are made up of six layers of canvas imbedded in a 3-8 inch thick rubber wall. They have shown no signs of wear in a 5,000-miles test.

The minimum load that is placed upon four 8-inch cushions is 1,400 pounds, with an air pressure of 30 pounds per square inch and a total contact area of 48 square inches at the bottom of the bulbs. The maximum load these 8-inch bulbs will stand with the same air pressure, is 4,320 pounds. This would increase the contact area to 144 square inches, and flatten out the bulbs to about 5 inches vertical diameter, but there would still be two or three inches for further vertical movement in case of a sudden shock or blow. The air pressure in the bulb determines the strain upon the walls, and as this air pressure never increases perceptibly, it can be seen that the strain is not very great.—*Scientific American.*

TWENTY-FIVE TONS OF ICE PER TON OF COAL

An English plant of the combined compression and absorption machine type has been unusually successful. Messrs. Ransomes & Napier, Ltd., of London and Ipswich, have put in for the Northeastern Ice Co., of Aberdeen, Scotland, a new plant. The old one consisted of two 20-ton, one 30-ton and one 50-ton compression machines. In place of the two 20-ton machines two 65-ton absorption machines were installed, giva a total of 210 tons per day. The absorption machines were worked on exhaust steam from the triple expansion engine operating the 50-ton compression machine. The same engine drives all the auxiliaries, including the dynamos for the electric lighting plant. A can plant was put in in place of the cell system formerly used. The new plant was tested in September last, 30-ton compression machine shut down, with these results:

Output of absorption machines.	135 tons.
" " compression machine	55 "
Total,	190 tons.
Steam consumption per hour..	5,800 lbs.
Temperature of cooling water..	55 deg. F.
Quantity of coal (slack at $3.37 per ton) used per day for entire plant, including all auxiliaries	7½ tons.

This gives 25 tons of ice per ton of coal for entire plant and 18 to 1 for absorption plant and auxiliaries. The new ice tank is not insulated at all and by insulating it in the usual manner the owners expect to get 30 tons of ice per ton of coal for the entire plant.—*Ice Trade Journal.*

AN EXPLOSION CAUSED BY HOT GREESE

It is not at all uncommon, in fact it is usual in a Lake Superior mine to see a miner stand over an open tool box containing dynamite and caps, select what powder he wants, and count out his caps, meanwhile heedlessly allowing the hot grease from his sunshine lamp to fall promiscously where it will. Apparently he is utterly oblivious to the fact that one of those hot drops of grease might easily explode a cap if it should happen to fall on the right spot. A most flagrant example of the old adage—"Familiarity breeds contempt." Nevertheless the unexpected sometimes happens. Apropos of this, I remember having had pointed out to me a particular spot on the hanging-wall of a certain drift in the old Osceola mine. The story goes that a miner left his stope to get powder and caps from his tool box, shortly after which a loud explosion was heard. Upon examination the miner was discovered in small pieces spread over the hanging-wall not far from the spot where his tool box had previously stood but of which there was no sign.

Another custom in vogue is a careless habit among the drill boys. Upon being

sent by the miners to bring powder and caps, they will stuff eight or nine sticks of powder, possibly more, together with a partly filled box of caps, into their shirt, the latter being partly open in front. Thus equipped they will climb into a stope, or down a winze, or perhaps run several lifts on the ladders. As far as I know there is nothing to prevent the cap box from dropping out of their shirt fronts if they should happen to lean too far forward. One misstep and—enough said.—*Correspondence Engineering and Mining Journal.*

SOUND CHARACTERISTICS

BY HUDSON MAXIM.

There are four, and only four, properties of sounds, whether oral or mechanical, and these are loudness, duration, pitch and tone color, the latter being sometimes called timbre. As I have shown in my recent book "The Science of Poetry and the Philosophy of Language," loudness and duration are quantitative properties, and pitch and tone color are qualitative properties.

I have carefully considered the comparative value of the automobile warning signals, and I think the sharp warning sound made by the Klaxon incomparably better than the musical, groaning, wailing or siren sounds made by others. The reason is that the Klaxon has a genuine warning note, while musical sounds possess no warning properties. Neither do mournful or wailing sounds warn. Thus they naturally produce the opposite effect.

We all know that it must naturally take more energy to make a loud sound than a low one, and more energy to make a sound for a longer period than for a shorter one. Consequently, loudness and duration, being representative of the energy consumed in producing a sound, have come to indicate the importance of the sound.

Pitch always varies with the tenseness of the feelings, in accordance with muscular tension. Hence pitch has come to indicate the degree of tenseness of the feelings of men and lower animals.

The tone color, or timbre, indicates the quality of the sound; in other words, it indicates the wave mixture or how the waves of sound are commingled. Different instruments always produce sounds of different tone-colors, and the tone-color always varies with variations in the character of the same instrument producing a sound. If a fiddle string be pulled strongly to one side and released it sets up waves of compression and rarefaction in the atmosphere. The longer the distance through which the string travels in its vibrations the larger are the sound waves and the louder the sound, other things being equal. The more rapidly the string vibrates from side to side the higher will be the pitch. The string not only vibrates as a whole, but it vibrates in segments upon itself. In other words, it trembles, and this trembling sets up smaller sound waves which, traveling upon and mingling with the large and fundamental waves produced by the string as a whole, give the fundamental waves or fundamental tones their tone-colors. The tone colors produced by a steel string, a catgut string and a silk string are all necessarily different from one another.

Now, as the oral instrument of men and of the lower animals constantly varies in shape with the character of the emotions inducing utterance, each different emotion produces sounds of a corresponding tone-color, and we have come to associate the different tone-colors in oral sounds with the emotions prompting the utterance. It is by means of the tone-colors in oral sounds, and by them alone, that we are enabled to tell whether the emotions of the speaker are painful or pleasurable, and also whether or not the speaker is uttering a warning cry or making a coaxing or wooing call.

Though warning sounds may differ widely in certain respects, there is one common characteristic possessed by them—they are harsh and untuneful; they are not pleasant to the ear. The warning growl of the dog, the cry of the fowl that voices danger, the warning snarl of a pair of tigers fighting over a piece of meat are not pleasant, or musical, or wooing sounds.

A wooing or musical sound is as inappropriate to the uses of the automibilist as would be a feather instead of a club to drive away an angry dog. It is the tone of the voice, far more than what is said, that calls a dog to us or drives him away from us. All animals are repelled by repellent sounds and attracted by attractive sounds. A musical sound made by an automobile horn tells a falsehood to the pedestrian whom it is expected to warn. It

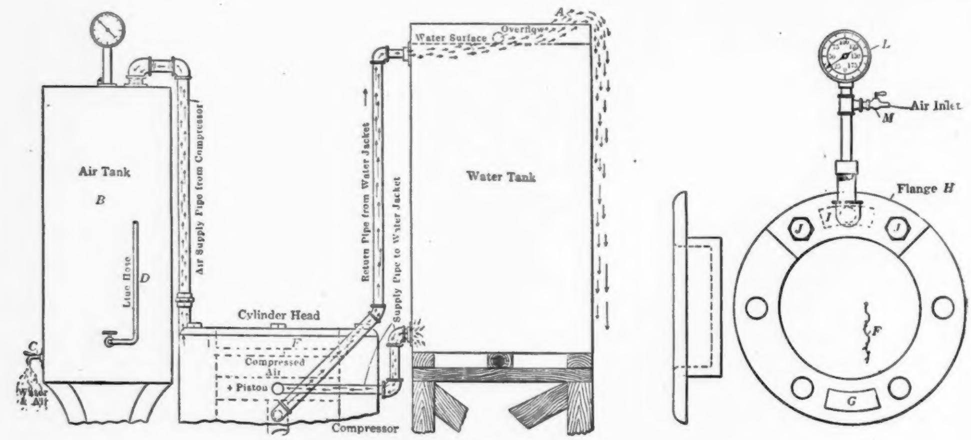
indicates that there is no danger when danger is most imminent.

I have tried many kinds of horns and made a serious study of this question, and I have found that to clear the way there is nothing like the Klaxon, with its harsh, untuneful warning.

Try it on the dog. Try to call a dog by telling him in a loud, harsh, warning voice to come to you, and also to try to send him from you by employing sweet, musical, wooing sounds.

the line hose *D* to the pneumatic riveting gun and hampered the workman. The water had to be let out of cock *C* at intervals of two hours.

As there was water in the air tank, and water spray, apparently caused by air, in the water tank, it meant there must be a leak somewhere between the water jacket and the cylinder. The machine had been examined for just such trouble only a week previous and a place was found that looked like a crack in the cylinder head. This was



CRACK IN CYLINDER HEAD.

A CRACK IN AN AIR COMPRESSOR CYLINDER HEAD

In visiting a shop recently we arrived at the engine room. This contained one 25-horsepower gas engine, and an air compressor, for operating pneumatic riveting machines and drills, that was rated at 80 pounds pressure constant flow. There was also a compressed-air tank, and a 300-gallon water tank to supply the water jacket of the compressor with water. The layout will be seen in Fig. 1.

While inspecting these it was noticed that at every compression-stroke of the piston in the air compressor a small spray of water would shoot diagonally across the surface of the water at the top of tank, and slop over the side; see *A*, Fig. 1. We asked about the cause of this but they did not really know. On opening the relief cock *C* on air tank *B* I noticed a lot of water coming out. This accumulated in the bottom of the air

tank, and was driven with the air through tested by filling the water jacket of the cylinder head with water but as the crack was hardly 0.001 of an inch wide no water would run out.

We, therefore, tested the cylinder head under air pressure and found that the crack, as shown at *F*, leaked enough to cause the trouble.

The method of testing the cylinder head is shown in Fig. 2. The inlet hole *G* was plugged up. Then flange *H* was made to cover hole *I* and this was secured tight with bolts *JJ* after a gasket was placed underneath. Connections for a ½-inch pipe were fitted into the flange and an air-pressure gage was attached to the end of the pipe; a tee *M* being fitted underneath it to admit the air.

The head was then filled with water to within ½ inch of the top and air was pumped into it. When the gage indicated 30 pounds pressure the water came trickling out

through the crack, shown at *F*. This showed why water accumulated in the air tank. At every suction stroke the water would be sucked from the crack into the air cylinder, whereas, at the compression stroke the air would enter the crack with 80 pounds pressure behind it. It then followed the easiest way out, which was the return pipe, and thereby caused the water spray at *A*.

The crack was closed with an oxy-acetylene welding apparatus and the cylinder head was immediately put back in the compressor. It is now doing good work, minus water in the air tank, and stray air currents that disturb the surface of the water tank.—*American Machinist.*

[The connection, in Fig. 2, between the air pipe and the water chamber of the cylinder head, where the test pressure was applied, is not readily discoverable. As to the accumulation of water in the air receiver, did not the writer know that water always is deposited there by normal compressed air, and that a "relief cock," as he calls it, is always provided to relieve the receiver of the water which is sure to accumulate? As the crack in the cylinder head would not leak water until a pressure of 30 lbs. was applied, and as the pressure of water in the jacket, as we must infer from the sketch, was not more than 2 or 3 lbs., how could any of it get into the air cylinder? It is quite possible that the crack would allow a little air to escape into the water when the high pressure occurred, but if with such a rush or in any such quantity as suggested by the sketch, how could any of it have been delivered to the air receiver? It is interesting to know of the repair of the head by oxy-acetylene welding, and shows how familiar and handy the process is becoming. A little use of oxy-acetylene upon the sketches and description above might have made a perfectly satisfactory job all around. Ed. C. A. M.]

Polaris, the north star, probably the star most familiar to all surveyors and to most other persons, is really three stars, though appearing as one, even through ordinary telescopes. By means of the great Lick telescope it was learned some time since that it is comprised of three distinct stars which revolve about each other.

DANGERS FROM HIGH AIR VELOCITIES IN MINES*

By Nile Robinson.

At the close of the fiscal year ended June 30, 1909, the chief of the Department of Mines of West Virginia, reported 50,567 men who were employed in underground work. The number is growing larger every year. Responsibility for the welfare and safety of this great army rests upon the inspectors appointed by the state and the owners of the mines; and it is pleasing to record the fact that they are working for the security of both men and property in perfect harmony.

Within a comparatively recent period the mining industry has undergone almost a complete revolution, changing from hand mining to machines, from animal haulage to electric motors, from fire-baskets to fans. The introduction of a new feature in any line of employment may cause inconvenience and possible loss of life until those who are to govern the innovation become masters of its power; but where the danger is self-evident precautionary measures are quickly adopted and security may soon be obtained. Occasionally a danger is concealed under a benevolent guise, and for a long time may remain undiscovered, because unsought. Is it possible that, in our efforts to secure so-called "perfect ventilation" through the introduction of powerful fans we have gone to an extreme, and have developed a hazard where we hoped to obtain a blessing? Is it possible that a mine can be over-supplied with pure, fresh air? Nearly all laymen, and probably a majority of operators, will hold that too much air cannot be delivered underground; and in acting upon that attractive belief hundreds of fans throughout the country are being driven to the capacity limit.

For the purpose of opening a discussion on this important subject of ventilation the writer will start with the declaration that no mine, unless it is generating gas, should be given more air at any time than is required by law; that is, "No less than 100 cubic feet of air per minute for each and every person employed in such mine"—delivered, of course, at his working place.

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*Paper read before the West Virginia Mining Association, Washington, D. C., December 16, 1910.

When air beyond the legal requirement is driven through a mine the surplus will serve no useful purpose whatever, and may constitute a positive danger.

The principal risk is due to the increase that must be made in velocity to handle the waste air. This is especially objectionable in dusty mines, where a high air speed will keep the fine dust in suspension and in perfect readiness for inflammation from a powder explosion. In this connection President William N. Page, in September, 1908, addressed a letter to the operators of West Virginia, pointing out the dangers from over-ventilation, as follows:

It is a physical impossibility to moisten dust to the point of safety in high velocity currents.

I know of no disaster remotely attributable to dust where high pressure fans were not employed. Until a comparatively recent date all explosions were attributed to fire-damp; and to guard against this danger we have created a new danger in the enormous volumes of air traveling at high velocities through restricted channels, which pick up every particle of dust within reach and keep it in suspension.

The compilation of mining records was undertaken by the State of West Virginia in 1883, and a study of the annual reports from that year to, and including, 1909—the last published—will show a relationship between underground fatalities and the change in method of ventilation that is entitled to serious consideration. Here are some figures gleaned from these reports:

Total number of men killed by explosions ot gas, powder, blasts and dust.

1883-1889	7 years	42 men
1890-1894	5 years	18 men
1895-1899	5 years	24 men
1900-1904	5 years	136 men
1905-1909	5 years	799 men

A certain percentage of these accidents can be attributed to causes that are in no way related to the air supply, but they are small compared with the heavy losses from explosion in which dust was the principal factor.

In the 17 years preceding 1899 there were only 84 fatalities—a period when fans were beginning to come into use. During the 10 years following 1899 the records show that 935 men were killed, practically all in mines with fans.

There is no invention connected with the mining industry that can contribute more to the safety and comfort of the men engaged in underground work than a properly regulated fan. We have only words of the highest praise for this method of ventilation, and what is here written is simply against the abuse, not against the use, of an invaluable aid in mining.

CHANGES IN THE METHOD OF VENTILATION.

Year.	Total No. of mines.	No. using furnaces, natural vent, etc.	No. using Fans.	Pct. Fans.
1897	221	144	77	34.7
1899	253	137	116	45.8
1904	584	263	321	55.
1909	795	284	611	77.

Almost without exception every serious accident caused by dust in recent years has occurred in a mine ventilated by a powerful fan. It is not unusual to find a strong uniform air current sweeping through a mine every hour of the day and night year after year, regardless of weather conditions and number of men employed.

The unwisdom of this practice is apparent when consideration is given to the fluctuating action of the air upon its admission to the mine. At one time it will deposit its moisture until beads of water appear upon every square foot of exposed surface, perhaps weakening the roof and causing decay in timber. At other seasons a reverse action takes place, and thousands of gallons of water will be withdrawn, leaving many tons of fine coal-dust, dried as in a furnace, and ready for ignition upon the propagation of any unusual flame.

An excess of moisture may weaken a roof and cause a heavy annual loss of life through accidents to individuals, and a very dry mine may become seriously dangerous from its liability to combustion. Each extreme carries a hazard that, in a majority of instances, is assumed without necessity.

A high air velocity holds fine, dry dust in suspension in thousands of eddies behind projecting timbers and in room necks, alcoves and roof arches, where it is in position to originate a disaster or give an opportunity for the widespreading of an explosion that, under true operating conditions, would be localized. In a number of high velocity mines the deaths from pneumonia have exceeded the fatalities from ordinary accidents; and we can trace scores of non-fatal injuries to collisions on mains

through the inability of workmen to maintain lights while traveling against strong air currents.

An earnest appeal is therefore made to the operators of the country, and especially to the Bureau of Mines, for a thorough investigation of the dangers that seem to be inseparable from an excessive inflow of air, particularly when it is driven underground at a high velocity.

Observations made by the Fairmont Coal Co. from June 1, 1908, to June 1, 1909—see Bulletin 425, United States Geological Survey—indicate that an ordinary mine, ventilated with 150,000 cubic feet of air per minute, will lose over 200,000 gallons of water per month at this season of the year.

We are now entering the winter period, when this moisture exhaustion is at the maximum. Fully believing that air in excess means a loss in moisture and a needless increase in danger, let me urge a reduction in fan velocity whenever it is possible. Economize in air, and only send underground a sufficient amount to satisfy the needs of the men who are at work until all questions relating to ventilation can be determined through scientific investigation by the Bureau of Mines, our numerous schools of mines and associations of mining engineers.

LUNG DISEASES OF MINERS

Dr. Crumpston, a commissioner of the West Australian government, appointed to investigate the causes of lung diseases among the miners of the country, has recently presented a carefully prepared report. He is said to have visited every mining district in the State and to have examined 2,050 miners, 1,805 of whom were actually at work when the examination took place. Dr. Crumpston had very carefully collated statistics, dealing with lung disease for the past decade, and from these it appears that tuberculosis of the lungs among miners has steadily increased, while pneumonia has decreased. At alll ages, between 25 and 60, the percentage of deaths is higher among miners than among the general population.

An important factor in producing the excess of deaths from respiratory disease is fibrosis. What is commonly styled miners' phthisis is thus designated by the commissioner, who thus differentiates between it and lung tuberculosis. His investigations show that in West Australia it is exceptional for these different diseases to coexist. He found among the 1,805 miners whom he examined at work that 33 per cent. of the machine miners were suffering from early fibrosis, against 7 per cent. of the non-machine miners, 3 per cent. of the truckers, and 24 per cent. of the dry treatment hands. Intermediate fibrosis was found among both machine and non-machine men, but late fibrosis only among machine men. Lung tuberculosis was present in twenty-eight cases. Tuberculosis was to be regarded as an infectious rather than industrial disease. He found no evidence of mine infection, and concluded that the disease was contracted directly by one man from another without any indirect agent.

Measures for the eradication of tuberculosis among miners should not stop short at the exclusion of infected men from the mines, but should include segregation of the tuberculosis persons who come into close association with miners. Fibrosis, which was due solely to the continuous inhalation of fine mineral dust, was so prevalent in the early stages as to demand serious consideration. The high percentage could not be attributed to the importation of cases from other states. Its effects were to diminish the area of lung tissue available for blood purification, and the amount of air and blood which could reach the lungs for the development of the fibrous tissues, but it did not necessarily cease when the patient was removed from the dusty environment. A mere temporary cessation of work among dust was, therefore, not of any value.

AIR BRAKE PROGRESS

The following, taken from records of high speed stops, will give an idea of the advancement in air brake efficiency. In the year 1878 a stop was made from a speed of 60 miles an hour in 1,130 ft., but weights of rolling stock increased to such an extent that the average train of 1900 could not be stopped from a speed of 60 miles an hour in less than 1,400 ft. by the quick-action brake, but the high-speed brake stopped this train in 1,050 ft. In 1908, under conditions in which the high-speed brake stopped a train of cars from a speed of 70 miles an hour in 1,900 ft., the L. N. equipment stopped the train in 1,680 ft., and in the year of

1909, when heavier locomotives and cars running at speeds of 60 miles an hour could not be stopped by any air-brake in less than 1,300 to 1,500 ft., the P. C. equipment stopped the train in 1,100 ft. All of the foregoing refers to emergency stops on level tracks and the work of the P. C. equipment is regarded as marvelous by air-brake men; but if the problem is regarded as merely a matter of miles an hour, records will show that trains were stopped from speeds of 60 miles per hour in 1,020 ft. in the year 1875, but stopping a modern train with the brake of 1875 would be an entirely different matter.—*Locomotive Engineering.*

MOVING PICTURE OF A FLYING BULLET

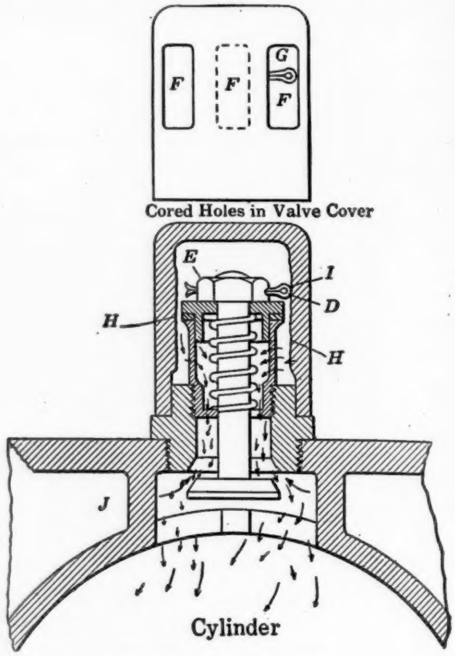
A cinematograph apparatus which takes pictures with intervals of one five-thousandth of a second has been invented by Dr. Cranz of the Military Academy of Berlin. A striking example of the power of the apparatus shows a bullet fired at a bladder of water that is hung on a string.

The eye only sees a little smoke from the pistol and a couple of holes in the bladder, from which the water runs; but when this is cinematographed and the film is shown slowly a very interesting series of operations can be watched.

First the bullet is seen approaching. It is traveling 1,000 feet a second, but it seems to move quite deliberately. In front of it and extending a long way above and below it is a dim line, bent sharply immediately before the bullet. A bullet can no more pass through air than a vessel can through water without making a wave; and this is the air wave. It is made visible on account of its different density, just as the waves in air are seen above a chimney or over hot ground.

Behind the bullet come scattered grains of the powder that have not been burned, and traveling more slowly still comes the wad. The bullet enters the bladder and disappears inside, a little water spurting out of the hole it makes. Then it reaches the other side, but it no longer cuts through at once, as it did when the bladder was backed up by the water.

Something like a finger seems to push the bladder outward into a long tube, then the tube opens and lets out the bullet, which gradually travels away. The tube does not at once collapse; its form is maintained by the stream of water which follows the projectile.



THE VALVE THAT STUCK.

A PUZZLING AIR COMPRESSOR TROUBLE

A writer in a recent issue of the *American Machinist* tells of a little trouble which befell a small air compressor, and of the difficulty experienced in finding and curing it. The compressor was to maintain a pressure of 80 lbs. for driving riveters, but it only managed to keep up to 30 lbs., and that of course was not enough, so machinists were called to find out what was the matter.

They took out all the suction and discharge valves and cleaned and oiled them; then on starting the compressor it kept up the required pressure for about 6 hours when it again dropped to and staid at 30 lbs. This was gone through with two or three times with no permanent cure.

It was finally discovered that there was an intermittent blow-back in the intake which showed that the inlet valves on one end of the cylinder did not close.

When we took these out and examined them, the account continues, we found that cotter pin *D,* which keeps nut *E* from turning, had an exceptionally large head, as shown in the cut. The casting that covers the assembled valve mechanism has three holes at *F F F.* When

the cotter pin head happened to be in front of a hole, as indicated at G, it had plenty of operating room. During the working of the compressor, however, the valve turned slightly, and the cotter pin worked away from the cored holes F F F. It then started to rub on the unfinished surface on the inside of the valve cover, and finally stuck on the high point at *I*.

Both valves had stuck the same way, and, of course, were constantly open. This allowed all air sucked in on the suction stroke to go backward and out through the same valves on the compression stroke, instead of going through the discharge valve, and from there into the storage tanks.

The compressor being of a double-acting design it left two valves in good working order to supply the tank, which accounts for the 30 pounds pressure.

The valve cover was bored out larger and deeper on the inside to allow the cotter-pin head perfect freedom, and this was all that was required to remedy this great trouble.

AIR MEN TO HAVE A PATRON SAINT

Paris, Feb. 1.—A little church in the department of Charente-Inférieure has been dedicated to aviators, and its patron saint, Notre Dame du Platin, has been adopted as the patron saint of flying men. Medals are being struck for aviators to wear or attach to their aeroplanes.

One side shows the protectress of aviators, with the motto, "Look upon her and take thy flight," while the other side shows the little church of Platin. Louis Bériot is the possesssor of the first of these medals.

Many aviators have mascots. Moore Brabazon always carries a figure of a lucky pig. Leon Delagrange, who was killed when flying in January, 1910, always believed the number 13 brought him luck, having been born March 13, 1873. Tabiteau has similar faith in the number 28.

Edmond Poillot, another victim of aviation, always carried a four leaved clover and never could pass an old horse-shoe without picking it up and carrying it about a few days.

Rolls, yet another victim, used to fasten a branch of mistletoe to his aeroplane before starting. Santos-Dumont looks upon the St. Benoit medal given him by the Countess d'Eu as a talisman and carries it set in a bracelet that never leaves his wrist. Wellman is said always to take a cat with him in his balloon, and Moisant adopted a cat as mascot during his trip from Paris to London.—*N. Y. Sun.*

WHAT OUR BREATH CARRIES

The ultra-microscope has enabled Prof. Courtade of Paris to analyze the human breath far more minutely than it has ever been done before. In a report to the Medical Society of Paris he says that exhaled air contains not only gases, such as nitrogen, carbonic acid, water-vapor, &c., but also a mass of tiny solid particles, some motionless and others mobile.

The latter, he surmises, may include bacteria, both rod shaped and globular. The presence of minute bits of cell tissue (epithelium) in the human breath he regards as positively proved.

The process followed by the investigator in his experiments was very simple. It was only necessary, he says, to examine a glass plate on which exhaled breath had been allowed to evaporate. Under the ultra-microscope he observed collections of dust composed of as rich a variety of substances as that left by evaporated drinking water.

Dr. Courtade hopes ultimately to be able to lay down a new standard of health by a series of comparisons of what he calls the "breath dust" of healthy and unhealthy persons.

A LOW RANGE RECORDING THERMOMETER

A new recording thermometer for the lower ranges of temperature has been recently developed by the Bristol Co., of Waterbury, Conn. The recording thermometers previously constructed by this company, and depending for their operation on the expansion of a liquid, a vapor or a gas, have been useful only for higher temperatures up to 800 degrees F. The principal feature of the new thermometer is a compensating device applied to the spiral pressure tube, through which the thermometer is made to give correct readings at the point where the sensitive bulb is placid, regardless of changes in temperature of the recording instrument itself. The compensating attachment affects the spiral tube only, and no effort is made to compensate for changes of temperature in the capillary tube connecting the sensitive bulb with the pressure coil. The volume of gas in the bulb, however, is very large in comparison with the volume contained

in the tube, so that the error due to changes in the tube temperature is negligible. The new thermometer is applicable for recording atmospheric temperatures of water, temperatures of brine in refrigerating systems and other temperatures below 212 degrees F.

TRIBOLUMINESCENCE

When you scratch or rub a substance and it emits light, that is triboluminescence. A strongly triboluminscent compound was described by W. S. Andrews at the Chicago meeting (1910) of the American Electro-Chemical Society. Its composition and mode of preparation is as follows: Zinc carbonate (chemically pure) 70 parts; flour sulphur, 30 parts; manganese sulphate, trace. Mix the zinc carbonate as a fine powder with the sulphur, then dissolve a small piece of manganese sulphate in distilled water and add enough of the solution to the powdered materials to make a thick cream. Thoroughly triturate in a mortar, then pour into a shallow glass or earthenware dish, and dry at a moderate heat. When dry reduce to fine powder, pack hard into a porcelain or fire-clay crucible with a tight cover, and subject to a bright red heat for 20 minutes. The mixture shrinks into a stone-like mass, which emits a train of yellow sparks when scratched.

The sparks will not set fire to inflammable gases and hence is not a substitute for flint and steel, or the cerium-iron lighters now on the market.

NEAR THE LIMIT FOR COMPRESSED AIR WORKERS

Preparations for the installation of electric traction in the Hoosac tunnel are progressing rapidly. This, as will be remembered, is a double track tunnel 4 3-4 miles long, with numerous heavy trains in both directions, so that the smoke is almost intolerable for the engineers and firemen, and the task of placing the overhead wire carriers without the temporary stoppage of traffic would seem to be impossible. It, however, is being done. A single track is made to suffice for business and the other track is given up to a working train. One car has tent-like structures upon its roof which can be extended to fit tightly up against the roof of the tunnel, thus enclosing sections of the surface to be worked on successively, the enclosure being supplied with "fresh" air by a compressor with an intake near the bottom of the tunnel. The pneumatic tools used for putting holes in the roof and other work are supplied with air from the same source. The condition of the air is bad enough at the best. The men wear big hats and goggles and rub their faces with grease paint. Telephone communication with the outside is constantly maintained.

DELAY ACTION FUSES

In certain classes of tunnel, or shaft excavating, delay action fuzes have been used to advantage. These are made so that a very short space of time intervenes between their ignition by the electric current and their detonation. Two kinds are manufactured, one kind called first period delay action fuzes, detonate a little before the other kind, called second period delay action fuzes, when both are connected in the same blasting circuit. When they are used in connection with regular electric fuzes, the latter will detonate at the instant the electric current passes through the circuit; the first period delay action fuzes will follow these, and the second period delay action fuzes will detonate a little later. By their use it is possible to fire one section of a blast, sufficiently ahead of the following section, for the material blasted by the charges in the first section to be blown out of the way when the next section is blasted.

CURIOUS EFFECT OF EXPLOSION

The effects of the recent explosion of the magazine of the Granite mine, at Victor, Colo., were shown in some curious ways. There were 89 large plate-glass windows in the town broken. A correspondent writing from there says, the damage was caused by concussion, not by flying missiles. The force of the explosion seemed to travel in waves, like those of sound, and took out about every other plate-glass window. The Portland Gold Mining Company has an office building with two doors and a large double window between them, facing the Granite magazine. The two doors were both blown from their hinges and one split its full length. The window escaped without a crack.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - Editor
FRANK RICHARDS, - Managing Editor
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W. C. LAROS, - - Circulation Manager

PUBLISHED BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—165 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa., Post Office.

Vol. XVI. MARCH, 1911. No. 3

CONTENTS

PARALLEL CAREERS OF INGERSOLL DRILL AND CAMERON PUMP

It was in a little shop on the corner of Second Avenue and Twenty-second street, New York, that both the Ingersoll drill and the Cameron pump originated, and the manufacture of both began under the same roof. The late Henry C. Sergeant, who is admitted to have done more in the invention and development of the rock drill than any other person, designed the first really successful Ingersoll drill, getting his fundamental ideas of the valve motion from Mr. A. S. Cameron. This was at a time when a reciprocating engine, like a pump or a rock drill, with no crank shaft to carry it over the center, was practically unknown. The first machines of this class were built on steam engine lines, the valve itself being mechanically connected with or operated by the piston. In the first Ingersoll drill, as in the first direct acting pumps, when the piston reached the end of the stroke it reversed the valve by direct mechanical contact with knuckle joints, rods or other devices, which intervened between the piston and the valve.

Here is where great credit is due Mr. A S. Cameron. He was seeking to perfect a pump which should be used in rough places where exposed parts were liable to wear or injury. He also wanted to design a valve which would open a large port at the end of the stroke the instant that the piston reached a certain point. This was hardly possible with a mechanically moved valve without excessive shock and wear. Cameron's invention, therefore, was to place a small tappet or knuckle in each cylinder head of the pump, which should serve as a trigger to trip and open, through contact with the piston, a small port connecting with one end or the other of the valve chamber. The valve itself was submerged in live steam pressure equal on both ends, and hence when this tripping action took place it reduced the pressure on one end so that then the full pressure on the other end caused it to reverse. In order to do this with the minimum shock at the tappet, and also taking into consideration the importance of having a small port controlled by such action, Mr. Cameron used a plunger piston which in turn overlapped the valve itself, this plunger piston having an area on each end which might be more or less according to the resist-

ance of the valve to the action of sliding on its seat. The valve itself was, and still is, a slide valve, which, as everybody knows, rests tightly upon its ports and does not leak through wear.

Sergeant had a problem more difficult than Cameron, because, in the first place, the speed of a pump is only about 100 feet per minute while that of a rock drill is four times as great. This high speed made it difficult to use any kind of a tappet trigger, and in order to get the quickest action of the valve Sergeant sought to avoid the use of the slide valve and to use the plunger or valve-moving device of Cameron as the valve itself. In doing this he ran against another difficulty: the valve in order to be tight on its seat would press so hard that the speed of the drill became sluggish, and to remedy this he ran a bolt through the center of the valve, which relieved it of a certain portion of this pressure.

Instead of the tappet trigger Sergeant moved his valve by causing the piston of the drill to undercover passages leading alternately to each valve end. Here we have the identical principle, so far as valve movement is concerned, which is embodied in the Cameron pump, namely, an equal pressure on both ends of the valve and the valve moving in consequence of reduction of that pressure on one end and the other alternately, the action itself being determined by the strokes of the piston. No better evidence is needed of the success of this valve action than the fact that the Ingersoll "Eclipse" drill and the Cameron pump are at work today with valves of this type.

The community of interests between Cameron and Ingersoll has extended from this inception to the present day. The castings for the first air compressors of the Ingersoll make were made in the Cameron foundry on East Twenty-second street. For many years, and until the Ingersoll works were moved to Easton, Pennsylvania, castings were made by Cameron.

Adam Scott Cameron was the youngest of four brothers, all of whom took up mechanical pursuits. While a youth, serving his apprenticeship, he was a student at Cooper Institute, giving his nights and spare time to study and research. He graduated with honors and at once applied himself to mechanical matters. He was early engaged in building the Sewell and Cameron crank-and-fly-wheel pump, which during the Civil War was in demand by the United States Navy and the Merchant Marine. At the close of the war the call for these pumps fell off, so that Mr. Cameron turned his attention to the design of a pump of greater adaptability and more general application. The standard Cameron pump was the result, its acorn shaped air chamber, the emblem of the clan Cameron, the oak, being his trade mark and continuing up to the present time. He died at an early age, but before death he stamped his ability and force of character upon the mechanical engineering of his age.

W. L. SAUNDERS.

FRIENDLY CO-OPERATION OF RIVAL POWERS

A few years ago we were hearing discussions as to the relative claims of electricity and of compressed air to employment for specific lines of service. There is, however, little talk now of electricity *versus* compressed air, or *vice versa,* because each has pretty completely demonstrated what it can do better than the other, and both now have their lines of employment rather definitely settled. The most noticeable thing, perhaps, is how each has helped the other, or, from the viewpoint of the case which we have immediately before us, we might be tempted to say how much has compressed air done to provide employment for electricity.

In some of the situations which occur it would seem to be difficult to settle the claims of the rivals. For instance, when a water power, hitherto unused, is "harnessed" to drive a generator, and where the current, after transmission perhaps for many miles, is applied to a motor which in turn actuates an air compressor, we might say either that the air compressor has provided employment for the electric current, or that the electric current has done a good turn for the air compressor and made possible its location there.

In case of the electric air drill the matter seems to be much simpler and clearer. Electricity unaided, has had its try at rock drilling, and it cannot be said that it has made any such success in that field as has the air-driven drill, nor is there apparently any likelihood that it will ever be able to, so that for operating rock drills it had almost ceased

to be thought of. In the electric-air drill, however, electric current is the only power transmitter, and in a way electricity might be said to be solely responsible for and solely to be credited with the results, but it is the air at the drill which actually does the work, so that after all every electric-air drill in operation represents so much employment which electricity would not have had except as it was provided for it by this ingenious air device.

The amount of the additional employment thus provided for the electric current is not immediately apparent. The electric-air drill incidentally leads the way to the employment of electricity for other purposes; for where it has heretofore been imperative to have the air compressor to drive the rock drills the presence of the compressed air on the spot has led to its employment also for the driving of pumps and hoists and such things, but the advent of the electric-air drill at once makes it possible to dispense with the air compressor and the air pipes entirely and to use the electric drive for everything. There are thus mine and quarry installations with electric drive throughout which would not have been possible without the electric-air drill.

This drill gets additional and exclusive employment for itself and for the current which drives it through the fact that it may be conveyed to, and installed and operated in the most inaccessible places. It can make itself at home wherever men can get to, wherever the wires can be laid, and where it would be impossible to lay air pipes or to convey and operate an air compressor within practical reach of the work.

All the other drills cost more to operate at the higher altitudes, but the electric-drill is unique in that in operation it is entirely independent of its atmospheric surroundings. The air which operates it being entirely enclosed, and not in touch with the external atmosphere, and not exhausting into the atmosphere, it makes no difference how much or how little the pressure of it may be.

The electric-air drill, it is to be remembered, compromises or sacrifices nothing of efficiency or advantage as compared with the air-driven drill. It strikes a blow as sharp and hard as ever was known; it can be moved and set and operated as easily as any, and it costs at the power house less than one-half what other drills cost.

ROCK DRILL STIMULUS

A rock drill is not at first thought the thing to attract the interest of the mechanically inclined. Those least informed about it are apt to pass it by with a casual and indifferent glance as a simple machine doing only the roughest of work. No one ever thought of putting a bit of finish to the outside of it, or even of painting it except with the thought of protecting it from the weather, and even the paint is always coming off second best in its encounter with mud and flying rocks.

Nevertheless, the rock drill is one of the great inventions, and a composite invention at that, to whose development many untiringly ingenious minds have contributed. No machine was ever more completely fitted for the strenuous life or lived it more successfully. Besides its actual work in breaking the rock and releasing the mineral treasures, in cutting the ways of traffic for the commerce of the world, whether borne on the land or on the water, in excavating foundation sites for the heaviest structures ever erected by man, its incidental influence and achievements also evidence its epoch making importance.

It introduced and made familiar the air compressor, which now finds employment in vast activities to which the rock drill is only remotely related. George Westinghouse told recently how the information of the driving of the first rock drills by air in Alpine tunnels, put him upon the right road to the air brake.

The entire line of air driven tools, the pneumatic hammers, riveters, caulkers, rotating drills, direct and motor driven hoists and the rest, are the children and the grandchildren of the original rock drill, and the industries in which these are employed and depended on owe their rapid growth to it.

It was noted recently upon the death of Chas. T. Porter how the exacting requirements of the high speed engine, and his careful supervision of its manufacture, had done much for the promotion of accurate and efficient methods of machine work in

the shops of the world. Nothing has been more insistent upon accurate workmanship, precise reduplication and especially upon the adaptation of the different materials to the several parts than the rock drill.

In a way, the requirements of the rock drill as to accuracy in the manufacture are as exacting as those of the linotype machine. All the working parts of each individual drill must fit with precision, so that they will work with absolute freedom and yet permit no leakage of air. All members, even to the entire machine, must permit of being taken apart by any one, anywhere, and then of being assembled again, *all without any kind of packing.*

This is simple enough, perhaps, for the individual drill, but this drill is usually taken apart only because something has gone wrong with it, and when the working conditions of the drill are considered, and the neglect and abuse and accidents to which it is subject are remembered, this is to be expected. In the reassembling of the parts, therefore, some of them will probably have to be replaced by new ones taken from the stock of duplicate parts always at hand. This may be in Michigan or Montana, in Africa or Australia, but the new pieces slip into their places and are at once ready for their work as though they had always been associated with that particular drill. This is one of the wonders of modern manufacture.

If any poor inventor is hoping to introduce some new machine, of a calibre at all commensurable with that of the rock drill, he could not fail to be impressed, if not appalled, by the enormous plant, the variety of ingenious machines, largely automatic, and the crowd of variously skilled workers, employed in the production of the rock drill.

NEW BOOK

A Pocket-Book of Mechanical Engineering, Tables, Data, Formulas, Theory and Examples, by Charles M. Sames. Fourth edition, revised and enlarged. Published by the author, Jersey City, N. J., 218 pages, 4¼x6½ inches. $2.00.

This is a real pocket book of a size convenient to carry. It contains a great amount and variety of reference matter in most compact form, and is up to date.

A CAISSON CATASTROPHE

A very unusual accident occured on Jan. 31, at Newark, N. J., where a pneumatic caisson was being sunk in the Passaic River for a pier for a Pa. R. R. bridge. Work was progressing in the usual way when a bucket, filled with excavated material, which had been hoisted out and clear of the air lock was dropped by the breaking of the chain. The fall broke the lock door, allowing the air in the caisson to escape and the water to pass into the working chamber. Four of the men within by some means managed to get out, but ten were drowned. No details of such an accident as this seem to be called for or could be of any value, although it would seem that some one was certainly responsible for the condition of the chain.

DISASTROUS POWDER EXPLOSION

Almost exactly at noon on Feb. 1, all downtown New York was shaken by an explosion of almost unheard of severity which occurred near the station of the Central R. R. of N. J., a mile or more away across the North River. A large quantity of black powder and dynamite, said to be for a South American shipment, was being unloaded from a car and carried into the hold of a lighter. As to the immediate cause and incidents of the explosion no one knows anything. The lighter and another vessel with their crews were so completely destroyed that none of the bodies of the men were found. A car of cement next to the car of explosive was destroyed, but a third car containing dynamite stood the shock so that its load did not blow up, but sticks of dynamite were scattered about the floor of the pier. About 40 freight cars were wrecked, the windows in the passenger station were blown out and scores of passengers on two ferryboats were injured. A man in a tugboat nearly a mile away was blown out of the pilot house into the water and fatally injured. The principal tangible effect in the city was the breaking of a great number of windows by the suddenly compressed air.

It is confidently asserted by experts that the initial if not almost the entire explosion was that of the black powder. "Contrary to general belief," as Dr. W. G. Hudson, of the E. I. du Pont de Nemours Powder Company, is reported "black powder is far more dangerous than dynamite. We believe the powder became ignited and in exploding detonated some

of the dynamite—not much of it. Dynamite freezes at about 45 degrees, Fahrenheit, and it is nearly impossible to explode it when frozen. The temperature on the day of the explosion and for a week before was below 45 degrees."

NOTES

So favorable is the atmosphere of Argentina to wireless telegraphy that the postmaster general proposes to substitute it for the present telegraph system.

A Swedish army officer has constructed an aerial torpedo propelled by a compressed-air motor. It is claimed to have an initial velocity of 984 ft. per second, and a maximum range of over 14,000 ft. Its charge consists of about 5 lb. of explosive.

The latent heat of ice is 142 B. T. U. That is to say, one pound of ice at 32 degrees F. will require 142 B. T. U. to melt it into water at 32 degrees F., or 142 B. T. U. must be extracted from water at at 32 degrees F. to freeze it into ice at 32 degrees F.

It is no longer recognized as an essential in profitable mining that ores be high grade, for some of the greatest dividend-paying mines in the United States are low-grade propositions. But such mines are made successes only through the ability of watchful managements in keeping the operating costs continually down to the lowest possible figure.

A recent performance in metal cutting, with oxygen is reported by the British engineering papers. It is stated that one man employed by the Knowles Oxygen Company, Ltd., cut through 42 girders, 15x5 in. section, in 4 3-4 hours, with a consumption of less than 200 ft. of oxygen and 300 ft. of hydrogen. Reckoning labor at 1 shilling per hour the cost figured out 6 pence per cut.

What seems to be a practicable invention is a device for locking the doors of English railway cars by means of the air pressure of the Westinghouse air brake. By means of a conveniently located switch, the guard instantly locks every carriage door on the train. Similarly, all doors are kept locked until the train has come to a stop, when they are released by the guard.

In Michigan, at Cook Falls on the Au Sable river, a 9,000 kw. hydro-electric plant is under construction which will have at the starting point a tension of 135,000 volts. The transmission system will extend to Flint, a distance of 125 miles, and to Battle Creek, a distance of 190 miles.

The Pope Mfg. Company, Hartford, Conn., now turning out automobiles as well as bicycles, is stated to be doing an unusually heavy business in the latter. In the fiscal year ending July 31, 1910, it shipped 57,000 bicycles. The current fiscal year the shipments will exceed 65,000, and will break any previous year's showing of the company, even in the old days when it was exclusively a bicycle concern, and when that industry was enjoying its boom 16 or 18 years ago.

The electric fan, which adds much to summer comfort, is far from useless in the winter. Shopkeepers have found that the circulation of air which it creates is the simplest and cheapest way to keep their show-windows free from frost. An electric fan used to create a forced draft in a furnace decreases materially the time necessary to heat the house in the morning, and in winter even more than in summer it may prove a useful adjunct to ventilation.

An injection of cement was the novel method lately adopted to make strong and serviceable two crumbling stone railway bridges at Hamburg. The arches—51ft. in span—were cracked in all directions, and small holes were bored partly through the masonry at the sides of the cracks, and thin cement mortar was forced into the apertures at a pressure of five atmospheres. When this had hardened, the stonework was found to be thoroughly consolidated.

From Japan come particulars of the invention of a smoke-preventing furnace in which compressed air is supplied to the fire through tubes forming an upper grate. The fuel is first deposited on this grate and partly consumed; the combustion gases pass downward through the grate, meeting the

supply of compressed air. By means of a reciprocating agitator the partially consumed fuel is caused to fall then upon a second grate of the ordinary type, where combustion is completed.

The weather Bureau has made progress toward the installation of apparatus, especially optical, for the study of the quantity of water vapor through a wide vertical extent of the atmosphere (as distinguished from the purely local indications of the hygrometer and the psychrometer). Spectroscopic observations with this end in view are to be undertaken by Prof. W. J. Humphreys.

The following rather unintelligibly worded news item appeared in the Butte (Mont.) Miner, Jan. 1, 32 years ago: "Two Ingersoll drills, for use on the lower level of the Alice mine, were received last week. They will be set at work within a day or two, but, with steam instead of compressed air, the experiences of doubtful issue should be necessarily imperfect ventilation of the lower levels not admit of steam being employed, drills will be laid aside until Bower's air compressors can be brought up from Salt Lake City next spring."

Ever since man has navigated the seas beyond the sight of land he has needed the most accurate measures of time, in order that he might tell his longitude with reasonable correctness. In 1714 the English government offered 20,000 pounds sterling to the man who would devise a chronometer so accurate that longitude could be told within 30 miles, and a descending reward down to half as much for the person who could tell it within 60 miles. In 1765 John Harrison, son of a Yorkshire carpenter claimed and was given the highest award.

A plant for testing the thrust of air propellers has been erected in England by Vicker's Sons & Maxim. The plant consists of a central tower supporting a cantilever one hundred and ten feet long and balanced by an opposite arm fifty-six feet long. A propeller shaft is mounted on the end of the long arm, which is driven by a 100-horse power engine placed in a cabin surrounding the tower. The motion of the arm is due entirely to the action of the propeller. Provision is made for measuring the thrust of the propeller with great accuracy.

A curious accident interrupted the operation of the Hudson & Manhattan power station a short time ago. The fine soot and dust from the back connections had been discharged and allowed to accumulate in the fan room beneath the boilers, and had been drawn by the fans into the air ducts and deposited as a coating of carbon upon their inside surfaces. In some unexplained manner this carbon took fire, and urged by the blast of the fans developed such a heat that the ducts were twisted all out of place, and the entire draft-producing mechanism of the station put out of business.

A new station on the Broadway division of the N. Y. subway at 191st street has been opened. This station is about 170 feet below the surface of the ground, and is farther from the surface than any other station of the Interborough subway. It has cost about $350,000, the work being done as an extra under the original subway contract. Besides the stairway at 191st street, there are four elevators, all in one shaft, and going down as far as the mezzanine floor of the station. Only about a quarter of a mile to the north the ground drops away so that the subway becomes an elevated road.

It is stated that in the Butte district about 700,000 lbs. of copper from mine and tailings water is precipitated monthly. The greater part of this comes from the mine water, about 550,000 lbs. The mine water is heavily charged with the metal in solution, in the form of a sulphate. The woodwork and walls of some of the mines are painted in the liveliest colors by the precipitated chemical. The water issuing from the mines and collected in launders is described as being of a pea-green hue. In these basins are distributed quantities of tin cans and scrap iron, which precipitates the metal.

On the excavation for the St. Mary's Falls Canal the Marsch-Robbins Co., Contractors, have adopted the use of a small air-operated hand hammer drill for drilling "pop holes" in large fragments of rock too large to be handled by the steam shovel. If the "mud cap"

method of breaking these fragments was employed, there would be a heavy damage to the windows in the adjoining city. The present method results in a considerable economy in explosives. A block 5x5x4 ft. in size requires one hole 28 ins. in depth in which ¼ lb. of 40 per cent. dynamite is placed with one exploder; "mud capping" would require about 5 lbs. of dynamite in this case.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 3.

980,257. FUME-CONDENSING APPARATUS. William R. Heslewood, Berkeley, Cal.

980,382. MECHANISM FOR UTILIZING THE EXHAUST-GASES OF INTERNAL-COMBUSTION ENGINES. Samuel T. Willis, Worcester, Mass.

4. In combination, a motor vehicle provided with a shaft, a turbine engine connected with said shaft to drive the same and propel said vehicle, a pressure tank or vessel in communication with said turbine, means to control the supply of fluid under pressure from said tank or vessel to said turbine, and an internal combustion engine connected with said pressure tank to discharge therein its exhaust gases, and having its shaft mechanically disconnected from the turbine driven shaft while the latter is being driven by said turbine substantially as described.

980,418. WALL-VALVE FOR PNEUMATIC CLEANING SYSTEMS. John T. Hope, Kansas City, Mo.

980,489. FLYING MACHINE. Henry J. Casanova, Chicago, Ill.

980,624. SAFETY TRAIN-AIR-LINE CUT-OUT COCK. George C. Gale, Alameda, Cal.

980,747. PNEUMATIC PIANO. William G. Betz, Steger, Ill.

980,753. AIRSHIP. William J. D. Bradford, Killeen, Tex.

980,756. DEVICE FOR CHARGING CAPSULES. Domingo Brescia, Quito, Ecuador.

1. A device for charging capsules, comprising a charging vessel adapted to receive gas under pressure, and arranged to be held in a plurality of positions, and baskets for removably holding the capsules within the vessel whereby the valves of the capsules are controlled by the position of the charging vessel.

980,810. AIR-VALVE FOR OIL-TANKS. John M. McDonald, Dubuque, Iowa.

980,813. PROCESS OF LIQUEFYING AIR AND SEPARATING OUT OXYGEN. Rudolph Mewes, Berlin, Germany.

980,828. DEVICE FOR COOLING THE AIR REQUIRED FOR MALTAGE. Emil Ott, Berlin, Germany.

1. An apparatus for cooling and moistening air comprising a chamber having an outlet opening in its bottom, a cooling battery comprising a series of superposed spaced conical rings arranged over said outlet opening the upper end of the battery being closed; means for spraying water upon the interior surfaces of the rings, and means for passing air from said chamber between the rings into the battery and thence downward to the outlet opening.

980,840. AIRSHIP. Matthew Rozboril and Peter Bursky, Binghamton, N. Y.

JANUARY 10.

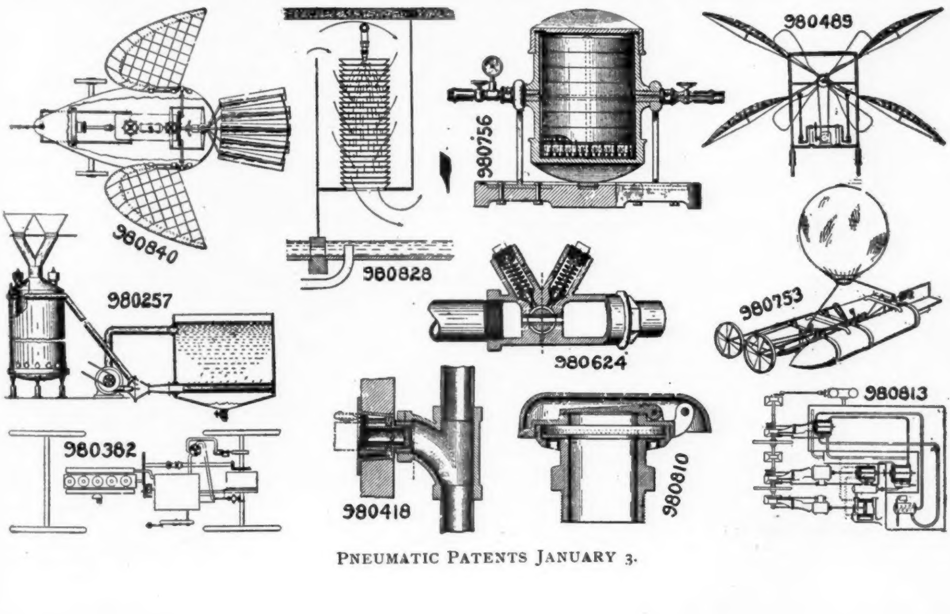
980,916. MEANS FOR AUTOMATICALLY PRODUCING AND UTILIZING AIR-PRESSURE. Henry E. Borger, Dayton, Ohio, and Albert S. Atkins, East St. Louis, Ill.

980,935. AERIAL PROPELLER. Thomas Fahey, Spokane, Wash.

980,944. SUCTION-CLEANER. Tracy Barbour Hatch, Alhambra, and Edwin Walter Goeser, Los Angeles, Cal.

980,977. VACUUM CLEANING APPARATUS. Paul C. Little, Carnegie, Pa.

1. In pneumatic cleaning apparatus, the combination of a reservoir for liquid, a connection for the dust laden air leading into said reservoir, a connection in the further path of the air leading from said reservoir, suitable means for producing suction therethrough, means for condensing the vaporized liquid passing through said connection, a receptacle for collecting the mixed



Pneumatic Patents January 3.

vapor and dust sucked therethrough, and a connection leading from said receptacle back to said liquid reservoir.

980,996. DEVICE FOR GENERATING AND ADMINISTERING OXYGEN. DAVID E. PARKER, Niagara Falls, N. Y.

981,036. ROCK-DRILL. ROLAND S. TROTT, Denver Colo.

981,041. PNEUMATIC CONVEYER. FRANK F. WEAR, San Francisco, Cal.

981,102. ELECTROLYTIC DEVICE FOR GENERATING PURE OXYGEN AND HYDROGEN, RENE MORTIZ, Wasquehal, France.

981,141. MEANS FOR PRODUCING A VACUUM. PERCY H. THOMAS, East Orange, N. J.

981,170. METHOD OF PREVENTING MINE EXPLOSIONS. JOHN W. COLEMAN, Maybeury, W. Va.

The herein described method of preventing the accumulation of dust particles in the air in a mine, said method consisting in introducing air into a mine at one point, forcing air out of the mine at another point, and hence maintaining a circulation of air; heating the air near the point of intake to the temperature of about 72 degrees F., and injecting into the current of air at the point where the same is heated, a jet

JANUARY 17.

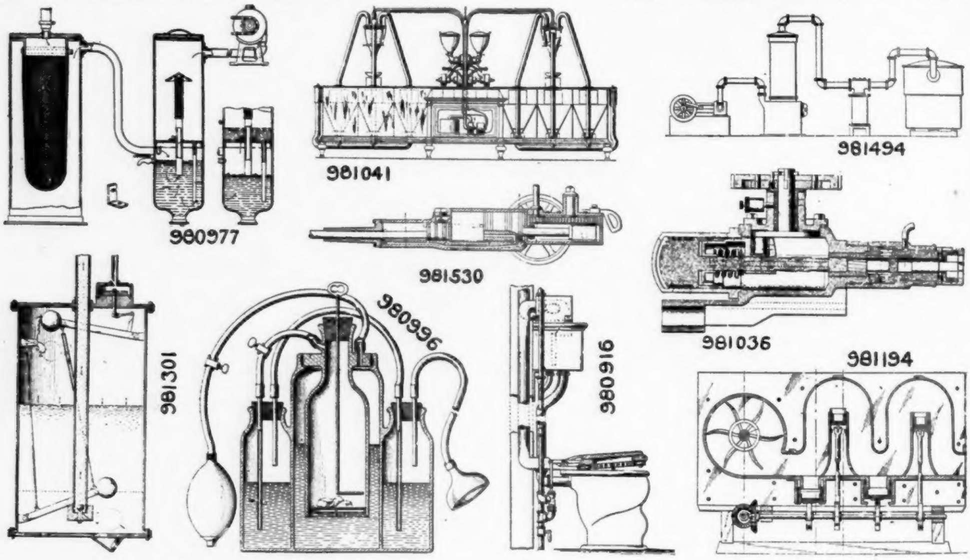
981,641. MACHINE FOR HAIR-DRYING AND THE LIKE. HENRY V. HALLIWELL, New York, N. Y.

1. In a device of the class described, an electric motor, a fan, a drum, an electric heating means detachably placed upon the outlet end of said drum, a nozzle detachably placed upon said heating means and of means for suspending said device.

981,755. AIRSHIP. JAMES M. KELLER, Detroit, Mich.

981,716. EJECTOR FOR WELLS. JOHN B. TAIT and THOMAS MALONEY, Maricopa, Cal.

1. An ejector for wells comprising an induction pipe for fluid, an eduction pipe for fluid, a supply pipe for compressed air, a reservoir cylinder of relatively large diameter compared to said air supply pipe, a sleeve at the upper end of said induction pipe, a cylinder surrounding said sleeve and separated therefrom at its lower end to form a contracted outlet and connected at its upper end to the eduction pipe, said reservoir extending a considerable distance above said sleeve on the induction pipe and the said contracted outlet, whereby air may accumulate



PNEUMATIC PATENTS JANUARY 10.

of steam in the same general direction as the said air current, to supply sufficient moisture to the air to cause the precipitation of the dust particles therein.

981,185. AERIAL APPARATUS. GATES M. FOWLER, San Francisco, Cal.

981,194. CONCENTRATOR. JOHN P. IBSON, Denver, Colo. Filed Oct., 19, 1909. Serial No. 523,418.

981,301. WATER-LIFT. JOHN E. OSMER, Chicago, Ill.

981,363. PNEUMATIC PIANO. WILLIAM G. BETZ, Chicago Heights, Ill.

981,367. AIR-CRAFT. FREDERICK BRACKETT, Washington, D. C.

981,410. AEROPLANE. JOSEPH A. GOODWIN, Berkley, Va.

981,494. VACUUM DRYING APPARATUS. EMIL WILHELM STROHM, Buffalo, N. Y.

981,498. VACUUM APPARATUS. PERCY H. THOMAS, Montclair, N. J.

981,501. VACUUM DRYING APPARATUS. LORIN W. TREICHLER, Williamsville, N. Y.

981,530. FLUID-ACTUATED TOOL. JOHN W. CANTY, Florence, Colo.

in the upper end of said reservoir above said outlet to equalize the outflow, as substantially set forth.

981,719. HOT-AIR DRYING PLANT. GEORGE HERBERT THORP, Yarasloff, Russia.

981,733. COOLING DEVICE FOR ENGINES. GEORGE WOLKE, Jacksonville, Ill.

981,748. LIQUEFACTION OF AIR AND ITS SEPARATION INTO ITS CONSTITUENTS. GEORGE CLAUDE, Paris, France.

981,755. ART OF LIQUEFYING GAS AND SEPARATING ITS ELEMENTS. EDSON F. GALLAUDET, Norwich, Conn.

1. The art or process of separating a mixed gas like air which consists in effecting the separation thereof solely by interactions between a downward current of liquefied portions and an upward current of unliquefied portions of the gas.

981,778. AIRSHIP. EDWIN LYMAN MADDEN, Ingersoll, Okla.

981,804. ROTARY PUMP OR COMPRESSOR ROBERT M. SLOAN and ZACHARY M. LINDLEY, Carthage, Mo.

981,899. PNEUMATIC HAMMER. ALBERT H. TAYLOR, Easton, Pa.

982,004. AUTOMATIC AIR-BRAKE COUPLING. THOMAS E. JENNINGS, Scott Haven, Pa.

982,008. SHOCK-ABSORBER. WILLIAM BRUCE KNAPP, Stoneham, Mass.

982,011. VACUUM-RENOVATOR. AUGUSTUS W. NOHE, Chicago, Ill.

982,161. MILKING MACHINERY. ALEXANDER SMAILL, JR., Tomahawk, near Dunedin, New Zealand.

982,190. PNEUMATIC SUSPENSION FOR VEHICLES. WILLIAM H. SHANKLAND, St. Johns, Oreg.

982,225. APPARATUS FOR LIQUEFYING GAS AND SEPARATING ITS ELEMENTS. EDSON F. GALLAUDET, Norwich, Conn.

982,227. APPARATUS FOR PRODUCING OZONE. LUDWIG GLASER, Pankow, Germany.

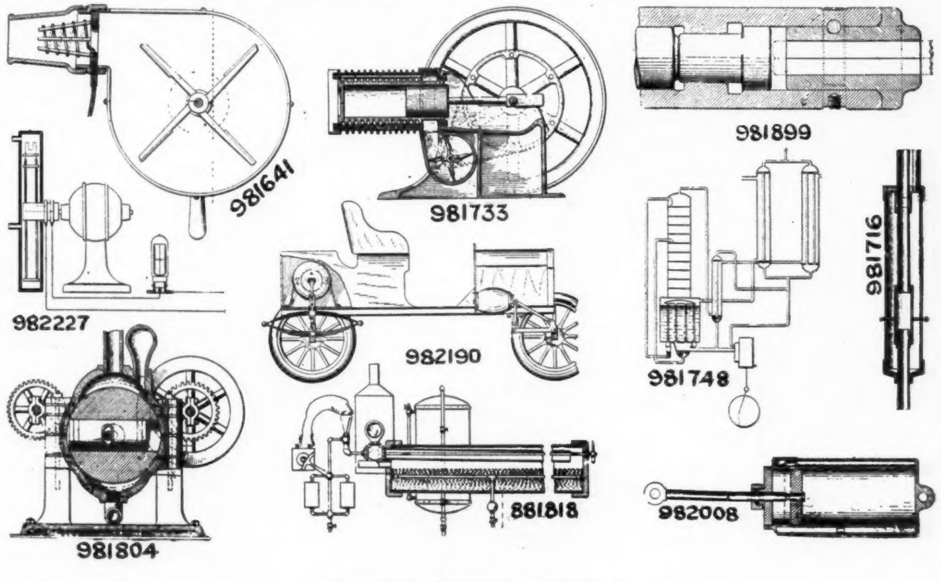
1. A device for producing ozone comprising a conductor of the second class which is cooled by strong air currents, and a resistance with high positive temperature coefficient connected in series with said conductor to prevent said conductor from loosing its conductivity because of the cooling action of said strong air currents.

982,540. JET PROPULSION. PAUL SKOUSE, Athens, Greece.

2. In driving means for vessels, a plurality of explosion chambers, independent accumulators for gas and air with passages leading to each of said chambers, means for compressing gas and air in said accumulators at a relatively high pressure, and means for admitting said gas and air at reduced pressure to said explosion chambers, in combination with a common cam shaft controlling the inlets to said chambers, a common exhaust passage into which said chambers open and forwardly and backwardly directed passages branching from said exhaust to the exterior of said vessel, substantially as and for the purpose described.

982,632. AIR-COMPRESSOR. FRANK M. PRATHER, Los Angeles, Cal.

1. An air compressor, comprising a circular frame keyed to a driving shaft, cylinders disposed in said frame extending radially from said shaft, pistons in said cylinders workably connected to a crank on a driven shaft and adapted to reciprocate in said cylinders, the driven shaft being in alinement with the driving shaft and the crank thereon carrying the pistons being eccentric thereto, and means to feed air into said cylinders on the relative rotation of said shafts.



PNEUMATIC PATENTS JANUARY 17.

981,818. PROCESS OF REGULATING AND MAINTAINING HUMIDITY. HARRY D. TIEMANN, Washington, D. C. (Dedicated to the public).

1. The herein described method of regulating and controlling the humidity in gas consisting in first raising the dew point to a temperature above that required for the desired vapor tension, then lowering the dew point by condensing the surplus vapor to the temperature corresponding to the proper vapor tension, maintaining this vapor tension by controlling the temperature of the condensing surfaces or bodies and then heating the gas and vapor to the degree finally desired.

JANUARY 24.

982,393. APPARATUS FOR FORCING AIR. IRA H. SPENCER, Hartford, Conn.

982,397. HAMMER-DRILL. ALBERT H. TAYLOR, Easton, Pa.

982,488. DEVICE FOR SEPARATING LIQUIDS OR SOLIDS FROM GASES. JOSEPH WILLARD GAMBLE, Philadelphia, Pa.

982,660. AIR-PUMP. JOHN DICKENS, Passaic, N. J.

982,680. AIR-VALVE. LORENZE IVERSEN, West Homestead, Pa.

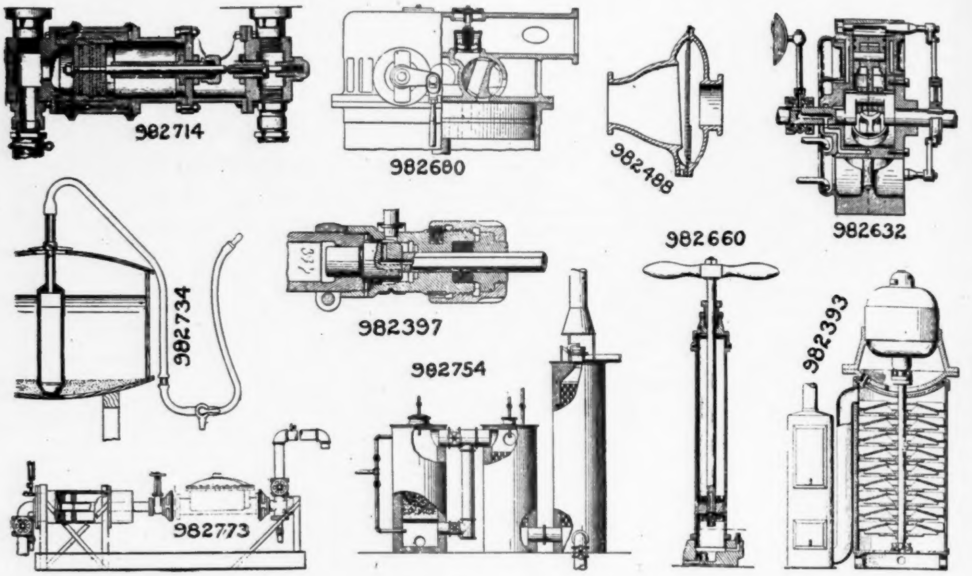
982,714. TESTING DEVICE FOR AIR-BRAKE SYSTEMS. FRED A. GILFUS, Auburn, N. Y.

982,734. SEDIMENT-REMOVER. ARTURO MARTINELLI, West Hoboken, N. J.

982,753. MULTIPLE-EFFECT GAS-COMPRESSING APPARATUS. GARDNER TUFTS VOORHEES, Boston, Mass.

982,754. PROCESS FOR THE MANUFACTURE OF GAS. GEORGE H. WARING, Omaha, Neb.

1. The process of making gas which consists in passing air through a burning fuel bed to heat it and generate combustible gas in a generator and passing off said gas to and burning it with secondary air in a chamber to heat the latter, and then passing oil down through the hot fuel bed to generate oil gas and oil vapors and partly decompose them into their elements



PNEUMATIC PATENTS JANUARY 24.

of which the carbon remains in greater part in the bed and completing this decomposition of the oil vapors and oil gas and the manufacture of gas rich in hydrogen by passing said vapors through said pre-heated chamber.

982,773. CLAMPING DEVICE. ALBERT B. WOOD, New Orleans, La.

1. A clamping device comprising of movable member provided with a passage, and means whereby fluid-pressure may be applied to the member, the fluid directly co-operating with said member having access to the passage.

JANUARY 31.

982,851. PNEUMATIC SAW. CHARLES J. OSLON, Muskegon, Mich.

982,860. VACUUM JAR-CLOSURE. WILLIS J. PEEBLE, Summitville, Ind.

982,895. ROTARY PUMP. ALBERT E. STOKER, Chicago, Ill.

982,903. ATOMIZER. JOHN S. THURMAN, St. Louis, Mo.

982,906. LUBRICATION APPARATUS. JOHN TRIFTSHAUSER, Hornell, N. Y.

982,923. SUCTION APPARATUS. FERDINAND BARBY, Paris, France.

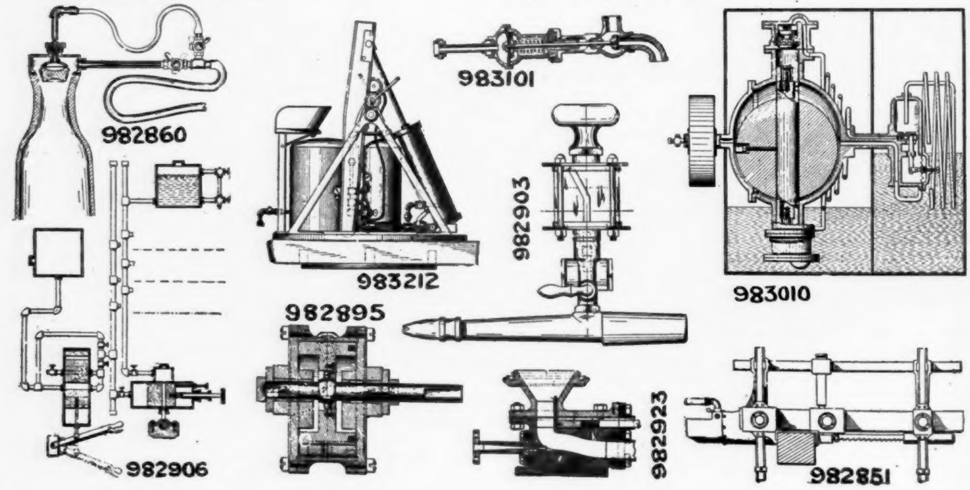
983,010. ROTARY COMPRESSOR. THEODORE R. VINZENT and FRED C. BELL, Alameda, Cal.

983,101. FLUID-PRESSURE GOVERNOR. MATTHEW J. WEBER, Columbus, Ohio.

983,212. MACHINE FOR RAISING AND LOWERING LADDERS. EDWARD F. DAHILL, New Bedford, Mass.

983,233. AERIAL MACHINE. JAMES HUMPHRIS, Johannesburg, Transvaal.

983,243-4. AIRSHIP. CASSIUS E. LAMBURTH, San Francisco, Cal.



PNEUMATIC PATENTS JANUARY 31.

CLASSIFIED BUYERS' GUIDE

Air Cylinder Oil.
- Atlantic Refining Co.
- Borne, Scrymser Co.
- Chicago Pneumatic Tool Co.
- Continental Oil Co.
- Fiske Bros'. Refining Co.
- Galigher Machinery Co.
- Standard Oil Co.
- Vacuum Oil Co.

Air Lift Pumps.
- Chicago Pneum. Tool Co.
- Curtis & Co., Mfg. Co.
- Galigher Machinery Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- McKiernan-Terry Drill Co.
- Westinghouse Air Brake Co.

Air Gauges.
- Galigher Machinery Co.
- McKiernan-Terry Drill Co.
- Westinghouse Air Brake Co

Air Receivers.
- Baldwin Locomotive Works.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Curtis & Co., Mfg. Co.
- Gardner Compressor Mfg. Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- Janney, Steinmetz & Co.
- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Stearns-Roger Mfg. Co.
- Sullivan Machinery Co.
- Westinghouse Air Brake Co.

Air Tanks.
- Baldwin Locomotive Works.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Galigher Machinery Co.
- Harris Air Pump Co.
- Ingersoll-Rand Co.
- Janney, Steinmetz & Co.
- McKiernan-Terry Drill Co.
- Pangborn Co., Thomas W.
- Porter Co., H. K.
- Westinghouse Air Brake Co.

Aftercoolers, Air.
- Bury Compressor Co.
- Chicago Pneum. Tool Co.
- Galigher Machinery Co.
- Ingersoll-Rand Co.
- McKiernan-Terry Drill Co.
- Porter Co., H. K.
- Stearns-Roger Mfg. Co.
- Sullivan Machinery Co.

Belting.
- Republic Rubber Co.
- Edw. R. Ladew.

Belt Dressings.
- Jos. Dixon Crucible Co.

Blowers.
- Cameron Stm.Pump Wks,A.S.
- Chicago Pneumatic Tool Co.
- Galigher Machinery Co.

Blowing Engines.
Cooper Co., C. & G.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.

Brakes, Air.
Westinghouse Air Brake Co.

Channelers.
Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Charging Stations.
Baldwin Locomotive Works.
Porter Co., H. K.

Coal Cutters.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Coal and Ore Elevator Buckets.
Clark Co., W. J.
Galigher Machinery Co.

Compressors, Air and Gas.
Bury Compressor Co.
Chicago Pneum. Tool Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Pangborn Co., Thomas W.
Powell Co., Wm.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

Compressor Fittings, Air and Gas.
Chicago Pneum. Tool Co.
Galigher Machinery Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.
Powell Co., Wm.
Republic Rubber Co.

Compressor Regulators.
Chicago Pneum. Tool Co.
Gardner Compressor Mfg. Co.
Mason Regulator Co.

Core Drills, Diamond.
Sullivan Machinery Co.

Core Drills, Diamondless.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Core Making Machinery.
Pangborn Co., Thomas W.

Corliss Engines.
Cooper Co., C. & G.
Galigher Machinery Co.
Sullivan Machinery Co.

Drilling Machines, Pneumatic.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Drill Sharpeners.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
T. H. Proske.

Dust Exhaust and Collector Systems.
Pangborn Co., Thomas W.

Electro-Pneumatic Machinery.
Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.

Engine Room Appliances.
Galigher Machinery Co.

Fans, Ventilating.
Galigher Machinery Co.
Sullivan Machinery Co.

Foundry Appliances.
Chicago Pneumatic Tool Co.
Curtis & Co., Mfg. Co.
Ingersoll-Rand Co.
Pangborn Co., Thomas W.

Foundry Facings.
Jos. Dixon Crucible Co.

Graphite Commutator Brushes.
Jos. Dixon Crucible Co.

Graphite Crucibles and Retorts.
Jos. Dixon Crucible Co.

Graphite Greases.
Galigher Machinery Co.
Jos. Dixon Crucible Co.

Graphite Paint.
Galigher Machinery Co.
Jos. Dixon Crucible Co.

Hammer Drills.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Hammers, Calking and Chipping.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.

Hammers, Riveting.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.

Helmets, Sand Blast.
J. M. Betton.
Pangborn Co., Thomas W.

Hoisting Machinery.
Galigher Machinery Co.
Lidgerwood Manuf. Co.
Sullivan Machinery Co.

Hoists, Air.
Chicago Pneumatic Tool Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.

Hose Coupling and Clamps.
American Metal Hose Co.
Chicago Pneumatic Tool Co.
Clark Co., W. J.
Cleveland Pneumatic Tool Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Sprague Electric Co.
Sullivan Machinery Co.
Westinghouse Air Brake Co.

Hose, Sand Blast.
Pangborn Co., Thomas W.

Hose, Steam and Air.
American Metal Hose Co.
Chicago Pneumatic Tool Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Goodrich Co., The B. F.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Republic Rubber Co.
Sprague Electric Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

njectors.
Penberthy Injector Co.

Locomotives, Compressed Air.
Baldwin Locomotive Works.
Galigher Machinery Co.
Porter Co., H. K.

Lubricating Graphite.
Jos. Dixon Crucible Co.
Galigher Machinery Co.

Lubricating Greases.
Borne, Scrymser Co.
Fiske Bros'. Refining Co.
Galigher Machinery Co.

Lubricating Oils.
Atlantic Refining Co.
Borne, Scrymser Co.
Continental Oil Co.
Fiske Bros'. Refining Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Standard Oil Co.
Vacuum Oil Co.

Lubricators.
Powell Co., Wm.

Magnetic Separators.
Pangborn Co., Thomas W.

Meters, Air.
Ingersoll-Rand Co.
Metric Metal Works.
St. John, G. C.

Mining Machinery.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Motors, Air.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.

Nozzles, Air and Sand.
Curtis & Co., Mfg. Co.
J. M. Betton.
Pangborn Co., Thomas W.

Oil Cups.
Galigher Machinery Co.
Powell Co., Wm.

Ore Concentrating Machinery.
Galigher Machinery Co.
Stearns-Roger Mfg. Co.

Pile Drivers, Pneumatic.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.

Pipe Joint Compound.
Galigher Machinery Co.
Jos. Dixon Crucible Co.

Plug Drills.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
Oldham & Sons Co., Geo.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Pumping Systems, Pneumatic.
Bury Compressor Co.
Curtis & Co., Mfg. Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.

Pumps, Air.
Cameron Stm. Pump Wks, A. S.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Pneumatic Displacement.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Harris Air Pump Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Pumps, Steam.
Cameron Stm. Pump Wks, A. S.
Galigher Machinery Co.
Stearns-Roger Mfg. Co.
Westinghouse Air Brake Co.

Quarry Machinery.
Bury Compressor Co.
Cameron Stm. Pump Wks, A. S.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.

Oldham & Sons Co., Geo.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Reducing Valves.
Mason Regulator Co.

Rock Drills, Air and Steam.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Rock Drills, Electric-Air.
Galigher Machinery Co.
Ingersoll-Rand Co.
Stearns-Roger Mfg. Co.

Sand Blast Machinery.
Curtis & Co., Mfg. Co.
J. M. Betton.
Ingersoll-Rand Co.
Pangborn Co., Thomas W.

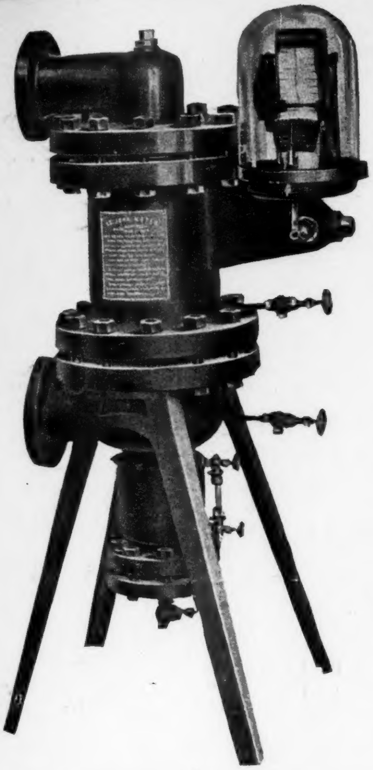
Sand Blast Systems.
Pangborn Co., Thomas W.

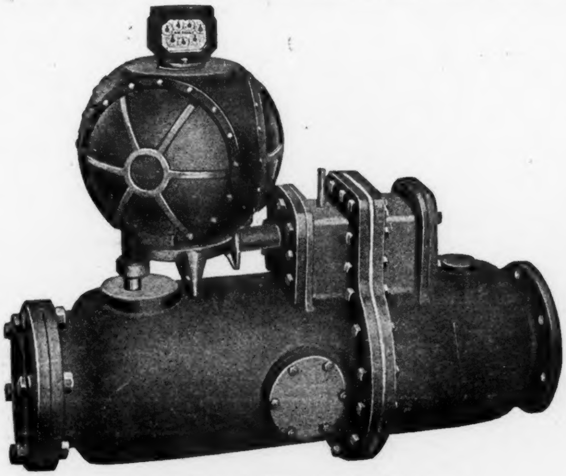
Sand Handling and Conveying Machinery.
Pangborn Co., Thomas W.

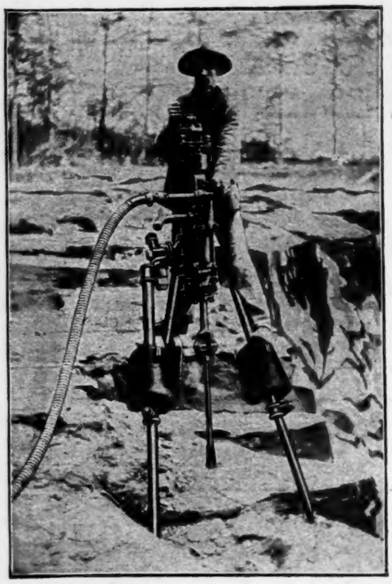
Sand Riddling Machines.
Chicago Pneumatic Tool Co.
Pangborn Co., Thomas W.

Stone Tools, Pneumatic.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Oldham & Sons Co., Geo.
Stearns-Roger Mfg. Co.
Sullivan Machinery Co.

Tools, Pneumatic.
Chicago Pneumatic Tool Co.
Galigher Machinery Co.
Ingersoll-Rand Co.
McKiernan-Terry Drill Co.
Oldham & Sons Co., Geo.
Pangborn Co., Thomas W.
Stearns-Roger Mfg. Co.







"Chicago Giant" ROCK DRILLS

Keller Stone Tools

Surfacers

Plug Drills

Hammers, Etc.

A full line of accessories.

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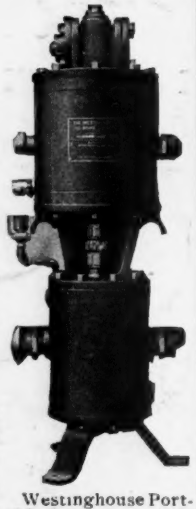

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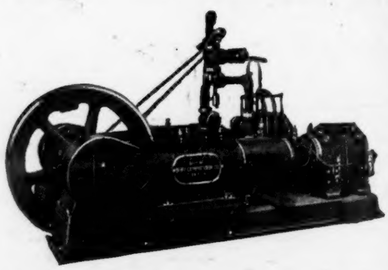

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